SUGARBEET RESEARCH

1990 REPORT

FOREWARD

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The report presents results of investigations strengthened by contributions received under Cooperative Agreements between Agricultural Research Service, U.S. Department of Agriculture, and the Beet Sugar Development Foundation; the California Beet Growers Association; and the Sugarbeet Research and Education Board of Minnesota and North Dakota.

Trade names occur in this report solely to provide specific information and do not signify endorsement by the U.S. Department of Agriculture or the Beet Sugar Development Foundation.

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SUGARBEET RESEARCH

1990 Report

Section A

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DUFFUS, J. E. Whitefly transmitted viruses of vegetable crops. Proc. of Sweetpotato Whitefly Mediated Vegetable Disorders in Florida. Inst. of Food and Agric. Sci., Univ. of Florida, p. 29. 1990.

Whitefly-transmitted disease agents cause significant losses throughout the world. They are responsible for the natural spread of a large number of economically important diseases in the tropical and subtropical areas. Recent years have shown an increase in losses in wide areas north and south of the tropics, approaching areas of intensive agricultural production such as the southern United States, Jordan, and Israel. These areas are in the apparently increasing range of *Bemisia tabaci* (Gennadius), the most intensively studied whitefly vector. Recent years have shown, if not an absolute increase, at least an increase in the awareness of disease losses caused by two other whitefly species, *Trialeurodes vaporarium* (Westwood) and *T. abutilonea* (Hald.), in temperate areas of the United States, Europe, Australia, and Asia.

The importance of the whitefly-transmitted agents becomes apparent when crops affected by the diseases induced by them are reviewed. Serious losses are induced on cassava, cotton, cowpea, bean, tobacco, soybean, tomato, squash, melon, watermelon, lettuce, sugarbeet, carrot, peppers, sweet potato, cucumber and papaya. Some 70 or more diseases have been reported to be induced by the feeding of infectious whiteflies. The relationships between these diseases, often poorly described, are not well established and in many instances they probably represent diseases induced by the same agent or strains of that agent.

The whitefly-transmitted diseases have been characterized in general on the basis of their transmission by whiteflies and the activity of the agents on host plants, such as symptoms and host range. A compilation of available data on the viruses themselves would suggest at least seven groups of viruses differing in type of virus particle, symptom type, and vector relationships. These include geminiviruses, and viruses similar to the closteroviruses, carlaviruses, potyviruses, nepoviruses, luteoviruses and a DNA-containing, rod-shaped virus.

The sweetpotato whitefly has since 1981 become the major pest of vegetables in the desert southwest region. The whitefly serves as the vector of viruses affecting at least 10 major agricultural crops including lettuce, cantaloupe, cucumber, melons, squash, watermelons, sugarbeets, tomatoes and carrots.

In the Mediterranean region, at least two distinct viruses are causing major losses of cucurbit crops in open and protected environments.

GERIK, J. S., J. E. DUFFUS, R. PERRY, D. C. STENGER, and A. F. VAN MAREN. Etiology of tomato plant decline in the California Desert. Phytopathology 80:1352-1356. 1990.

Tomato plant decline (TPD) has been a limiting factor in the production of fresh market tomatoes in the desert areas of California since 1977. Diseased plants are characterized by stunting, leaf rolling and leaflet chlorosis. The disease occurs only in fields with a history of previous tomato crops and can reduce yields by as much as 80%. Although TPD is known to be soilborne, the cause of the disease has not been determined until now. Tomatoes grown at 14 C in soil collected from a field with a history of TPD became infected with a tombusvirus that was serologically indistinguishable from the BS-3 strain of tomato bushy stunt virus (TBSV). When tomato debris infected with TBSV was used to infest soil, seedlings planted in this soil developed symptoms of TPD and were positive for TBSV infection if grown at 16 C. In addition, TBSV was consistently found associated with field-grown, symptomatic plants collected during 1987 and 1988, as determined by ELISA. Eight tomato cultivars, which in field observations were considered to be susceptible or tolerant to TPD, were mechanically inoculated with TBSV and grown in the greenhouse. The symptoms were most severe on the TPD susceptible plants, but were mild on TPD-tolerant plants. Symptom development was also found to be dependent on temperature in a manner consistent with temperature sensitive replication of the virus. These experiments implicate TBSV as the etiological agent of TPD.

GERIK, J. S., J. C. HUBBARD, AND J. E. DUFFUS. Soil matric potential effects on infection by *Polymyxa betae* and BNYVV. Proc. 1st Symposium Int. Working Group on Plant Viruses with Fungal Vectors, Braunschweig, p. 20. 1990.

Infection of sugarbeet by viruliferous *Polymyxa betae* was studied in an infested soil from the Salinas Valley of California. The soil was classified as a clay loam and was composed of 31.5% sand, 29.5% silt, and 39% clay. Soils were maintained at matric potentials between 0 and -180 mbars with tension plates composed of Büchner funnels with fritted glass disk and water columns of various lengths suspended below. Infection was studied at matric potentials < -200 mbars by planting seed in soil which was then adjusted to the desired matric potential with a soil moisture extractor and sealed in plastic beakers. After 2 weeks the plant roots were assayed for infection by beet necrotic yellow vein virus (BNYVV) by sandwich ELISA, and for *P. betae* by microscopic examination. Plants incubated in the -0.3 bar and wetter soils were positive for BNYVV. No plants incubated in -0.4 bar or drier soil were infected with the virus. The results indicate that *P. betae*, the vector of BNYVV, is unable to infect sugarbeet roots in this soil when the matric potential is -0.4 bar or less. These data are similar to those reported for *Plasmodiophora brassicae* by previous researchers (Dobson *et al.*, Phytopathology 72:1598-1600). Our results indicate

that early infection by these pathogens in irrigated sugarbeets may be avoided by planting into pre-irrigated soil, rather than irrigating immediately after planting, as is the common practice in California.

HOEFERT, L. L., J. D. McCREIGHT, and R. D. CHRISTIE. Microwave enhanced staining for plant virus inclusions. Stain Technology (In Press). 1991.

Plant virus inclusion bodies can be stained specifically with established staining methods for light microscopy. The procedure can be augmented by a short and gentle microwave treatment to provide better staining intensity and much shorter staining times. The method is useful in preliminary sampling prior to collection for electron microscopy and to plant pathologists, plant breeders, and diagnosticians as a rapid means of plant virus characterization.

LEWELLEN, R. T. Use of introductions to improve populations and hybrids of sugarbeet. Agron. Abstr. p. 98. 1990.

Until the mid-1930's, all sugarbeet seed was imported. Because of the need for regional adaptation and disease resistance, public and private breeding programs were started in U.S. early this century. By 1940, the crop was grown from domestic developments. These early open-pollinated varieties and synthetic pools were derived from European cultivar types and have been the germplasm base for nearly all commercial hybrids developed in the U.S. Since 1940, germplasm from introductions other than a recently reestablished international sugarbeet seed trade involving elite lines and commercial hybrids appears to have had little impact or use in the development of commercial hybrids. However, there are evidence and conjecture that some of the gains in disease resistance and genetic traits that revolutionized sugarbeet breeding were derived from crosses to wild beets and species dating more than 60 years ago. Renewed interest in introductions and wild species of *Beta* has occurred. Recent research has identified useful traits and these are being transferred into population improvement programs.

LEWELLEN, R. T. Registration of rhizomania-resistant germplasm of *Beta vulgaris*. Crop Sci. 31 (In Press). 1990.

Rhizomania is one of the most devastating diseases known on sugarbeet. Varietal resistance is the best means to provide protection against this disease. Germplasm C28 was released to the sugarbeet seed industry as a source of host-plant resistance to this disease.

LIU, H. Y. and J. E. DUFFUS. Beet pseudo yellows virus: purification and serology. Phytopathology 80:866-869. 1990.

Beet pseudo-yellows virus (BPYV) has been purified from BPYV-infected *Nicotiana clevelandii* Gray. Purified preparations had an $A_{260/280}$ nm ratio of 1.315 and contained long flexuous rod-shaped particles approximately 12 nm wide and 1,500 to 1,800 nm long. Virus yield ranged from 100 to 400 ug/kg of leaf tissue. An extinction coefficient of 3 $(mg/ml)^{-1} \times cm^{-1}$ at A 260nm was used. An antiserum to BPYV was prepared that has enabled us to diagnose BPYV-infected plants by the indirect enzyme-linked immunosorbent assay (ELISA) but not the direct ELISA test. The disease, transmitted by the greenhouse whitefly (*Trialeurodes vaporariorum* (Westwood)), has been diagnosed previously only by transmission and host range tests. This is the first report of the description of the particle morphology of BPYV and the production of an antiserum that can be used for serodiagnosis.

SAUNDERS, J. W., W. P. DOLEY, J. C. THEURER, AND M. H. YU. Somaclonal variation in sugarbeet. In: Biotechnology in Agriculture and Forestry, Vol. 11. Somaclonal Variation in Crop Improvement I. Ed. by Y.P.S. Bajaj. Springer-Verlag, Berlin, New York. pp. 465-490. 1990.

Somaclonal variation includes forms of permanent genetic change produced during passage of cells through tissue culture. Current procedures in sugarbeets for converting genetic variation at the cell level to the whole plant level are reviewed, as is the range of such variation reported to date at the whole plant level. Procedures for using somaclonal variation to alter biochemical behavior in sugarbeet are discussed, as are considerations for studying effects of mutants and incorporating them into commercial varieties with improved processing behavior or resistance to disease or herbicides.

STENGER, D. C., D. CARBONARO, and J. E. DUFFUS. Genomic characterization of phenotypic variants of beet curly top virus. J. General Virology 71:2211-2215. 1990.

Full-length infectious DNA clones were constructed for four distinct phenotypic variants of beet curly top virus (BCTV). Southern hybridization assays indicated that each cloned BCTV genome shared sequence homology with pBCT-028, a full-length infectious DNA clone of a California isolate of BCTV previously characterized by others. Restriction endonuclease maps of the cloned BCTV genomes were distinct from one another. Infectivity assays determined that plasmids containing tandem repeats of BCTV genomes were generally more infectious than excised linear DNA inserts. Progeny virus, derived from plants inoculated with cloned DNAs, differed in their ability to infect sugarbeet, *Beta vulgaris* L., and the severity of symptoms produced in *B. vulgaris* and other experimental hosts.

STENGER, D. C., J. E. DUFFUS, and B. VILLALON. Biological and genomic properties of a geminivirus isolated from pepper. Phytopathology 80:704-709. 1990.

A geminivirus causing leaf curl and distortion symptoms was isolated from pepper (*Capsicum annuum*) cultivated in Texas. The Texas pepper geminivirus (TPGV) was transmitted persistently by *Bemisia tabaci* and was also transmitted mechanically to species of the solanaceae. Electron microscopy of purified virions revealed typical geminate particles. Extracts from infected plants, but not uninfected plants, contained a putative replicative form (RF) DNA species of 2.6 kb that was double stranded, circular, and supercoiled. Viral RF DNA, linearized by digestion with the restriction enzymes *Eco*RI or *Hin*dIII, was cloned into *Escherichia coli* plasmid pUC 8. Analysis of cloned DNA by Southern hybridization and restriction endonuclease mapping indicates that two distinct species were cloned from RF DNA. One TPGV DNA hybridized with DNA A of tomato golden mosaic virus (TGMV); however, neither TPGV DNA hybridized with TGMV DNA B. Infectivity assays using cloned TPGV DNAs demonstrated that both DNA species were required for systemic infection of test plants. These results indicate that TPGV is a typical whitefly-transmitted, bipartite genome geminivirus not previously known to occur in the United States.

YU, M. H. Wild type descendents of mutant dihybrids yield the highest number of seed per fruit. Rep. Tomato Genet. Coop. 40:43. 1990.

Dihybrid crosses among three selected tomato mutants, the dominant Curl, *Cu*, the crispata dwarf, d^{cr} and the dwarf curly leaf, *cu-3*, produced all three parental and two nonparental plant types in the F_2 and later generations. The two nonparental groups were the wild type and the midrib-invisible curly leaf type (MI). Progeny belonging to the same phenotype but derived from different parental sources set fruit of different sizes. The fruit size was not correlated with the seed production. Fruites produced from the wild type derivatives, regardless of their relative size and hybrid origin, contained the highest number of seed when compared to fruit of other phenotypes having the same ancestry. The comparative rates of decrease in seed number per fruit ranged from 22.7% in Cu progeny of the *Cu* x d^{cr} cross to 95.7% in MI plants of the *Cu* x *cu-3* cross. The expanded leaves of the wild type plants, in contrast to the altered leaf texture of the mutants, seemed to have a positive effect on the high seed yield capability as a result of larger canopy of leaf surface.

YU, M. H. Observations on the occurrence and inheritance of some induced variations in sugarbeet. ASSBT 26th Bienn. Meet. Abstr. p. 50. 1991.

Explants of certain sugarbeet genotypes were induced to generate new plants through an in vitro process. When leaf sections from plants with monosomic additions that were descendents of sugarbeet and *Beta procumbens* interspecific hybrids were cultured, the majority of regenerants expressed similar phenotypes and growth profiles to the donors. Nonetheless, over 20% of regenerated plants had leaf intumescence, chromosomal, or both, variations. In diploid sugarbeet, on the other hand, variations in derivatives from leaf cubes and unpollinated ovules were primarily chromosomal. In either case, the majority of karyotypic variation was chromosome doubling. Transverse sections of the intumescent leaves exhibited multi-layered epidermis with proliferated cells that formed wartlike protrusions and occasional trichomes, especially beneath the vascular bundles of minor veins. The malformed leaf traits were transmitted to progeny when intumescent diploid and tetraploid monosomic additions were crossed to normal sugarbeet pollinators. From these crosses, additional aneuploid classes of progeny with up to 39 chromosomes occurred. Leaf intumescence was inherited as dominant character and was associated with the addition chromosome.

Papers Published Since Abstracted in Previous Report

DUFFUS, J. E. Infectivity Neutralization. In Serological Methods for Detection and Identification of Viral and Bacterial Plant Pathogens. American Phytopathological Society. pp. 161-164. 1990.

DUFFUS, J. E. Density Gradient Precipitation. In Serological Methods for Detection and Identification of Viral and Bacterial Plant Pathogens. American Phytopathological Society. pp. 161-164. 1990.

DUFFUS, J. E., B. W. FALK, and G. R. JOHNSTONE. Luteoviruses - One system, many variations. Book Chapter in World Perspectives on Barley Yellow Dwarf, CIMMYT, Mexico, D. F., Mexico. P. A. Burnett, Ed. pp. 86-104. 1990.

LEWELLEN, R. T. and BIANCARDI, E. Breeding and performance of rhizomania resistant sugarbeet. Proc. 53rd Winter Congress, I.I.R.B., Brussels, Belgium 53:69-87. 1990.

Assessment of red hypocotyl color components in the monosomic addition sugarbeet germplasm through regenerated progenies

M. H. Yu

Utilizing the in vitro culture process, regenerated plants were induced from callus of sugarbeet (Beta vulgaris L.) leaf discs. Additional genetic information on the monosomic addition germplasm was thereby obtained. The majority of regenerated plants from sugarbeet line 2488 had phenotypes similar to their donor parents. This was especially true for traits such as red hypocotyl color and resistance to cyst nematode. However, several individuals among the derivatives had expressed karyological and morphological changes. One of the noticeable variations was leaf intumescence (Li). This phenotype was found to be in association with the alien addition chromosome. The fact that all regenerated intumescent plants as well as their intumescent progenies manifested red hypocotyl color (R), resistance to Heterodera schachtii Schm. (Hs), and the aneuploidy extra chromosome(s) indicated there were linkages for loci R, Li, and Hs in the addition chromosome. Notwithstanding, regenerated plants that had either the monosome addition genomes, resistance to cyst nematode, red hypocotyl color, or combinations of these traits were not necessarily intumescent.

The red hypocotyl color is one of the most important traits in conventional sugarbeet genetics and breeding, both in basic and applied research. In this study, the genetic composition of the red plant color is in question because the source sugarbeet material was derived from open pollinations. The monosomic addition germplasm line used has a background of Beta vulgaris L. and B. procumbens Chr. Sm. hybridization followed by multi-generation backcrosses to sugarbeet with the purpose of incorporating Hs factors into sugarbeet genome. When plants of the monosomic addition, red hypocotyl, intumescent progeny were pollinated by diploid, green hypocotyl, self-compatible, smooth leaf plants of sugarbeet, their progeny segregated for plant color as well as leaf traits. However, segregation pattern for leaf intumescence and hypocotyl color somehow deviated from that of single traits in diploids.

From seven crosses, the following F_2 progeny segregation types (Table 1) were observed: (a) four families consisted of progeny with red, intumescent-red, and green hypocotyls; (b) two families with red and intumescent-red; and (c) one family with red and green. Self-crosses of the red intumescent F_2 plants produced progenies consisting of five group types, i.e., (a) red, intumescent-red, and green; (b) red and intumescent-red; (c) red and green; (d) intumescent-red and green; or (e) only green hypocotyl plants in F_3 and F_4 generations. Self-crosses of the non-intumescent red F_2 plants, on the other hand, gave either red and green progenies (type c) at about 3:1 ratio or only green individuals (type e) with no leaf intumescences. The green hypocotyl F_2 plants, which were all non-intumescent, did not segregate (type e).

The above results indicated that the red hypocotyl color of the monosomic addition sugarbeet genotypes was conditioned by two separate R elements, one in the addition chromosome and the other in a recipient homologous chromosome. However, whether the R allele that is located in the addition chromosome was inherited from B. procumbens ancestor or from B. vulgaris origin is yet to be determined.

TABLE 1. Transmission of hypocotyl color and leaf intumescence in progeny of crosses between leaf intumescent, red hypocotyl, monosomic addition plants and normal, self-compatible, green hypocotyl, diploid sugarbeet pollinator

Segr	Seed parents			Red		Green	
type	Genotype		Color	Normal	Intum	Normal	Intum
Intumescent F_1:							
(a)	2508	F_1	Red	6	5	8	1[a]
	4122	F_1	Red	5	5	3	
	4123	F_1	Red	14	2	2	
	4226	F_1	Red	19	6	5	
(b)	3819	F_1	Red	11	5		
	5901	F_1	Red	23	7[b]		
(c)	2584	F_1	Red	8		3	
Intumescent F_2 and F_3:							
(a)	3819	F_2	Red	8	3	2	
	4122	F_2-1	Red	2	5	13	
	4122	F_2-2	Red	16	3	2	
	4123	F_2	Red	9	2	3	
	4226	F_2	Red	7	5	4	1[a]
	5901	F_2	Red	5	2	1	
	5901	F_2	Red	7	5	1	
(b)	4122	F_3	Red	4	2		
(c)	3819	F_2	Red	3	1[a]	1	
(d)	4122	F_3	Red		1	1	
	4226	F_2	Red		7	44	
	4226	F_3	Red		3	11	
(e)	4122	F_3	Red			8	
	4226	F_3	Red			3[c]	
Non-intumescent F_2:							
(c)	2508	F_2	Red	13		6	
	4123	F_2	Red	55		16	
(e)	2508	F_2	Green			12	
	4122	F_2	Green			20	
	4226	F_2	Green			16	

[a]Traits of intumescence vanished on subsequent leaves.
[b]Hypocotyl color of 3 plants appeared pale.
[c]One plant small with 9 and 18 chromosome sectors.

TEST 190. Means and Ranges for S^f, MM, A:aa popn-911 & -912 at Salinas for bolting evaluation.

100 entries x 3 reps, RCB
1-row plots, 16 ft. long

Planted: December 4, 1990
Harvested: October 29, 1990

Variable	Mean	Range	LSD (.05)	CV(%)
Sugar Yield (lbs/a)	14600	11982 - 17105	0.0	12.7
Root Yield (t/a)	46.0	37.0 - 53.5	0.0	12.4
% Sucrose	15.9	14.7 - 17.2	1.3	5.0
% Bolting	5.9	0.0 - 29.4	8.3	86.6
Beets/100 ft	141	115 - 160	22.0	9.7
RJAP (%)	81.0	78.4 - 83.6	0.0	2.4
PM Score	0.5	0.0 - 2.0	1.2	161.2

TEST 1390. Means and Ranges for S^f, MM, A:aa popn-991 & -912 at Salinas under BYV infection

100 entries x 3 reps, RCB
1-row plots, 16 ft. long

Planted: February 28, 1990
Harvd: October 24, 1990
BYV Inoc.: May 18, 1990

Variable	Mean	Range	LSD (.05)	CV(%)
Sugar Yield (lbs/a)	10600	8295 - 13575	1786	10.5
Root Yield (t/a)	34.9	27.6 - 44.0	5.5	9.8
% Sucrose	15.2	13.5 - 16.1	0.7	3.0
Beets/100 ft	162	135 - 190	25.8	9.9
RJAP (%)	83.6	78.4 - 88.1	3.9	2.9
Mean VY Score	3.7	3.0 - 5.0	0.8	13.9
Mean PM Score	5.2	3.7 - 7.0	1.3	15.0
Tests 2890 for Powdery Mildew and Downey Mildew				
Mean PM Score	3.9	3.0 - 9.0	--	--
Mean DM %	3.5	0.0 - 6.0	--	--

TEST 3590. Means and Ranges for half-sib families from S^f, MM, A:aa popn-911 & -912 at Salinas under moderate rhizomania

100 entries x 2 reps, RCB
1-row plots, 17 ft. long

Planted: June 5, 1990
Harvested: November 6, 1990

Variable	Mean	Range	LSD (.05)	CV(%)
Sugar Yield (lbs/a)	4807	3363 - 6780	0.0	20.9
Root Yield (t/a)	17.6	12.0 - 23.8	0.0	20.7
% Sucrose	13.7	12.4 - 15.2	1.4	5.0
Beets/100 ft	170	135 - 241	56.2	16.7
Mean PM Score	4.9	3.2 - 7.5	2.0	20.3

TEST B490. Means and Ranges for half-sib families from S^f, MM, A:aa popn-911 & -912 at Brawley under moderate LIYV

72 entries x 4 reps, RCB
1-row plots, 10.5 ft. long

Planted: September 19, 1989
Harvested: May 22, 1990

Variable	Mean	Range	LSD (.05)	CV(%)
Sugar Yield (lbs/a)	8150	4117 - 10825	1791	15.8
Root Yield (t/a)	25.7	14.3 - 32.2	5.3	14.9
% Sucrose	15.8	14.3 - 17.0	1.1	4.9
% Bolting	2.3	0.0 - 24.8	5.6	174.9
Beets/100 ft.	133	114 - 150	0.0	16.7
% Clean beets	93.6	86.3 - 97.9	3.5	2.7
ppm Na	276	150 - 408	0.0	39.3
ppm K	1992	1259 - 2857	693.7	25.0
ppm NH_2-N	248	156 - 388	0.0	37.0
Impurity Value	8312	5309 -11398	0.0	26.3
% Recov. Sugar	92.1	88.9 - 95.2	0.0	2.5

TEST 2590. PERF OF C0:C1:C2:C3:C4 SYNTH. OF POPN-790+THEIR HYBRIDS, SALINAS, CA., 1990

16 entries x 8 reps, RCB
1-row plots, 30 ft. long

Planted: April 17, 1990
Harvested: October 23, 1990

Variety	Description	Cycle	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Root Rot %	Beets/ 100' No.	RJAP %	Powdery Mildew Rating	Downey Mildew 6/18	Downey Mildew 7/2
Y846H67	7767aa x Y746	767	9046	32.22	14.02	0.0	136	81.5	3.8	1.7	3.6
Y846H82	6756aa x Y746	C310/6	8775	30.55	14.34	0.0	138	82.4	3.9	1.9	2.5
Y846H35	6790Kaa x Y746	C3	8606	30.10	14.31	0.0	126	81.7	4.3	1.6	2.7
Y846H76	7776aa x Y746	776	8253	29.40	14.01	0.0	138	81.7	4.1	2.1	2.7
Y846H34	7790Faa x Y746	C2	8152	29.27	13.94	0.0	129	82.5	4.1	3.6	5.2
Y846H36	7790Laa x Y746	C4	8098	29.09	13.89	0.0	131	81.8	4.2	3.8	4.1
Y846H33	7790Daa x Y746	C1	7778	29.09	13.31	0.0	129	80.2	4.4	2.1	4.2
Y846H32	7790Caa x Y746	C0	7381	26.83	13.76	0.0	132	79.1	4.8	3.6	5.5
6790K	4790Kaa x A	C3,Syn 2	6796	24.61	13.93	0.0	136	81.4	4.6	1.2	2.7
7767	6767aa x A	POPN-767	6542	23.25	14.00	0.0	138	80.2	4.1	1.8	3.1
8790L	7790Laa x A	C4,Syn 2	6266	23.52	13.50	0.0	139	81.3	4.8	1.1	1.8
7790F	1790Daa x A	C2,Syn 2	6012	21.55	13.96	0.0	142	79.0	4.9	1.8	2.7
7790D	7790Daa x A	C1,Syn 2	5868	22.56	13.13	0.0	138	81.5	5.1	2.2	3.2
8755	7755,6aa x A	NB C310/5,6	5731	20.64	13.94	0.0	140	80.8	3.9	0.9	1.9
7776	6776aa x A	popn-776	5447	20.61	13.19	0.4	132	80.6	4.6	1.5	1.9
7790C	7790Caa x A	C0,Syn 2	5086	19.73	12.93	0.0	139	78.1	5.4	2.2	2.8
MEAN			7115	25.81	13.76	0.0	135	80.9	4.4	2.1	3.2
LSD (.05)			1116	3.51	0.00	0.0	9	0.0	0.8	0.0	0.0
C.V. (%)			15.8	13.7	7.6	131.4	6.5	4.3	17.4	144.7	6.6
F value			10.7	11.1	1.3	1.0	2.3	1.1	3.1	0.7	0.9

TEST 690. GCA EVALUATION OF MULTIGERM GERMPLASM, SALINAS, CA., 1990

32 entries x 8 reps, RCB
1-row plots, 30 ft. long

Planted: February 12, 1990
Harvested: September 12, 1990

Variety	Description	Acre Yield		Sucrose	Bolters	Root Rot	Beets/ 100'	Powdery Mildew
		Sugar Lbs	Beets Tons	%	%	%	No.	Avg.
R970H68	7767HO x RZM R871	15313	50.04	15.31	1.4	0.3	146	3.7
8909H68	7767HO x 7909	15241	51.31	14.88	0.0	0.5	156	3.6
R970H20	87-309H3 x RZM R871	15174	48.52	15.63	0.5	0.0	160	5.0
Y931/SH77	7776HO x Y731/S	15105	49.21	15.36	0.0	0.0	146	3.8
Y931/DH20	87-309H3 x Y731/D	15087	49.04	15.39	0.0	0.0	155	4.4
9912H68	7767HO x RZM 8908...11	14989	49.78	15.05	0.6	0.3	155	4.1
R939/4H20	87-309H3 x R839C4	14929	47.07	15.86	0.0	0.0	167	4.3
Y931/DH77	7776HO x Y731/D	14906	48.76	15.31	0.3	0.0	160	3.6
Y731H20	86-309H3 x F86-31/6	14853	46.70	15.89	0.0	0.0	160	4.7
9910H68	7767HO x 8910	14848	49.08	15.19	0.0	0.0	147	3.8
9910H20	87-309H3 x 8910	14773	47.41	15.61	0.0	0.0	158	5.8
Y954H68	7767HO x Y854	14771	48.08	15.35	0.0	0.3	143	3.7
Y954H77	7776HO x Y854	14761	47.11	15.64	0.0	0.0	143	4.1
9102H8	F82-546H3 x 8102	14709	45.29	16.26	0.0	0.3	154	3.7
R939/4H68	7767HO x R839C4	14695	47.62	15.45	0.0	0.0	151	3.3
9911H68	7767HO x 8911	14662	48.01	15.27	0.0	0.0	158	3.4
9911H20	87-309H3 x 8911	14568	46.07	15.81	0.0	0.0	158	5.2
Y846H20	87-309H3 x Y746	14560	46.42	15.70	0.0	0.3	164	4.6
Y731H77	5776HO x F86-31/6	14537	48.92	14.88	0.0	0.0	149	3.6
Y931H20	87-309H3 x Y731	14440	47.45	15.21	0.0	0.0	154	4.1

TEST 690. GCA EVALUATION OF MULTIGERM GERMPLASM, SALINAS, CA., 1990

(continued)

Variety	Description	Acre Yield Sugar lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/ 100' No.	Powdery Mildew Avg.
9912H20	87-309H3 x RZM 8908...11	14367	46.14	15.60	0.3	0.0	157	5.4
Y931/SH20	87-309H3 x Y731/S	14307	44.50	16.04	0.0	0.0	154	4.1
Y954H20	87-309H3 x Y854	14260	44.13	16.15	0.0	0.0	152	5.3
Y846H68	7767HO x Y746	14238	47.26	15.06	0.0	0.0	154	3.3
Y949H68	7767HO x Y849	14159	45.66	15.50	0.0	0.0	158	3.2
Y954H8	F82-546H3 x Y854	14109	47.39	14.88	0.0	0.0	158	3.9
N902-5H20	87-309H3 x 8204,6	13997	46.69	15.00	0.0	0.0	158	5.8
Y931H77	7776HO x Y731	13880	46.11	15.04	0.0	0.0	150	3.6
Y949H20	87-309H3 x Y849	13873	43.93	15.80	0.0	0.0	150	4.2
9101H8	F82-546H3 x 8101	13813	45.51	15.16	0.0	0.0	152	3.8
HH54	Holly (L543003)	13620	40.94	16.65	0.0	0.5	157	4.4
N902-7H68	7767HO x 8207,8	13080	47.76	13.69	0.6	0.0	149	3.8
MEAN		14519	47.12	15.43	0.1	0.1	154	4.1
LSD (.05)		865	2.67	0.61	0.5	0.0	11	0.6
C.V. (%)		6.0	5.7	4.0	459.4	507.6	7.2	15.5
F value		2.8	4.6	6.0	2.6	1.3	2.1	10.1

TEST 890. EVALUATION OF MONOGERM LINES, TOPCROSS HYBRIDS WITH C54 & C31, SALINAS, CA., 1990

32 entries x 8 reps, RCB
1-row plots, 30 ft. long

Planted: February 12, 1990
Harvested: September 18-19, 1990

Variety	Description	Acre Yield		Sucrose	Bolters	Root Rot	Beets/ 100'	Powdery Mildew
		Sugar Lbs	Beets Tons	%	%	%	No.	Avg.
4757	Betaseed (1-6-89)	16870	54.10	15.60	0.0	0.3	157	3.7
Y931/SH18	88-790-68H26 x Y731/S	16181	50.60	15.98	0.0	0.0	156	4.3
Y731H89	C790-68HO x F86-31/6	16058	52.60	15.27	0.0	0.6	144	3.6
Y954H85	C790-92HO x Y854	16038	53.83	14.90	0.0	0.3	149	4.3
Y954H20	87-309H3 x Y854	15988	50.45	15.85	0.0	0.3	153	5.5
Y954H52	8767-30HO x Y854	15955	54.37	14.70	0.0	0.0	134	3.8
Y731H42	C742-24HO x F86-31/6	15952	51.55	15.46	0.0	0.3	145	3.4
Y931/SH89	88-790-68CMS x Y731/S	15926	51.04	15.60	0.0	1.7	146	3.7
Y931H39	C762-17HO x Y731	15902	53.27	14.95	0.0	0.8	159	4.3
Y931H89	88-790-68CMS x Y731	15805	53.24	14.90	0.0	1.4	144	3.8
Y931/DH89	88-790-68CMS x Y731/D	15743	51.50	15.32	0.0	1.6	148	3.1
Y954H18	88-790-68H26 x Y854	15630	49.17	15.90	0.0	0.3	158	4.4
6625	Betaseed (12-88)	15618	46.24	16.89	0.0	1.1	151	4.2
Y954H39	C762-17HO x Y854	15606	53.32	14.63	0.0	1.1	146	3.9
Y954H84	C790-69HO x Y854	15564	51.29	15.16	0.0	0.0	150	4.3
Y954H89	88-790-68CMS x Y854	15544	50.53	15.39	0.0	1.5	139	4.2
Y954H40	C313CMS x Y854	15520	50.76	15.27	0.0	0.3	135	3.9
954H26	87-309CMS x Y854	15496	47.86	16.21	0.0	0.0	138	6.0
Y954H66	C766-23HO x Y854	15452	50.18	15.40	0.0	0.0	145	3.9
Y954H54	C767-46HO x Y854	15333	50.82	15.09	0.0	0.0	141	3.9

TEST 890. EVALUATION OF MONOGERM LINES, TOPCROSS HYBRIDS WITH C54 & C31, SALINAS, CA., 1990

(continued)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/ 100' No.	Powdery Mildew Avg.
Y954H70	C766-62HO x Y854	15292	51.42	14.89	0.0	0.0	147	4.2
Y954H50	8767-20HO x Y854	15278	48.75	15.66	0.0	0.0	145	3.9
Y954H38	C312CMS x Y854	15210	50.46	15.06	0.0	0.3	140	3.8
Y954H37	85-306CMS x Y854	15193	51.69	14.70	0.0	0.8	154	4.1
Y954H72	83-718HO x Y854	15188	51.62	14.68	0.0	0.6	148	4.0
HH 54	Holly (L543003)	15184	46.56	16.30	0.3	1.2	145	4.8
Y954H87	C790-55HO x Y854	15158	49.39	15.36	0.0	0.3	145	4.3
SS-NB2	Spreckels (1-22-88)	15135	49.24	15.39	0.0	0.0	155	4.8
Y954H92	F85-796-22CMS x Y854	14721	48.68	15.10	0.0	0.0	150	4.5
Y954H3	F82-562HO x Y854	14291	47.83	14.95	0.0	0.8	152	4.6
US H11	(786442)	14105	50.06	14.09	0.0	0.0	160	5.6
Y954H8	F82-546H3 x Y854	13770	46.79	14.74	0.0	0.3	151	4.4
MEAN		15460	50.60	15.29	0.0	0.5	148	4.2
LSD (.05)		1031	2.88	0.59	0.0	1.1	9	0.6
C.V. (%)		6.8	5.8	3.9	1600.0	234.0	6.0	14.0
F value		2.8	4.4	7.3	1.0	1.8	4.7	8.6

TEST 990. EVALUATION OF POPULATION HYBRIDS, SALINAS, CA., 1990

32 entries x 8 reps, RCB
1-row plots, 30 ft. long

Planted: February 12, 1990
Harvested: September 19-20, 1990

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/ 100' No.	Powdery Mildew Avg.
R939/4H121	8862aa x R839C4	16828	53.50	15.76	0.5	0.0	152	3.8
9912H68	7767HO x RZM 8908...11	16303	54.01	15.13	0.3	0.0	165	4.1
9911H115	8857aa x 8911	16190	52.36	15.46	0.0	0.0	154	4.2
Y954H118	8855aa x Y854	15821	49.22	16.10	0.0	0.3	149	4.6
9910H116	8853aa x 8910	15768	50.85	15.50	0.6	0.0	148	4.8
Y954H115	8857aa x Y854	15739	51.11	15.43	0.0	0.6	147	4.3
Y954H18	88-790-68H26 x Y854	15680	49.56	15.84	0.0	0.0	163	4.8
9866H46	8906aa x 8853,5,6	15674	50.91	15.39	0.3	0.0	147	5.3
4757	Betaseed (1-6-89)	15658	51.46	15.23	0.0	0.3	159	3.8
9911H68	7767HO x 8911	15518	51.52	15.05	0.0	0.0	165	4.2
Y954H111	8851aa x Y854	15421	49.23	15.66	0.0	0.0	149	4.8
Y954H117	8856aa X Y854	15284	49.38	15.51	0.0	0.3	160	3.7
R939/4H112	8854aa x R839C4	15268	49.15	15.54	0.6	0.0	137	4.1
9867H46	8906aa x 8852,7	15194	49.61	15.31	0.0	0.3	156	5.8
9911H118	8855aa x 8911	15188	48.12	15.81	0.0	0.0	155	4.6
9910H68	7767HO x 8910	15157	50.52	15.04	0.0	0.0	155	4.7
Y954H90	C790aa x Y854	15084	50.57	14.90	0.0	0.3	148	4.1
Y954H67	8767aa x Y854	14977	50.33	14.90	0.0	0.0	152	4.2
Y954H96	C796aa x Y854	14975	48.48	15.45	0.0	0.0	145	5.1
Y954H113	8858aa x Y854	14964	48.50	15.44	0.0	0.0	149	4.1

TEST 990. EVALUATION OF POPULATION HYBRIDS, SALINAS, CA., 1990

(continued)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/ 100' No.	Powdery Mildew Avg.
Y954H20	87-309H3 x Y854	14962	48.60	15.41	0.0	0.0	156	4.9
9876H46	8906aa x 8860,1,2,3	14927	51.01	14.63	0.0	0.3	143	5.8
Y954H80	C310aa x Y854	14919	48.82	15.29	0.0	0.0	158	3.8
9859H46	8906aa x 8850,1,4,8	14790	49.84	14.86	0.3	0.0	132	5.5
Y954H122	8863aa x Y854	14748	47.33	15.57	0.0	0.0	146	4.1
Y954H86	8787aa x Y854	14746	49.10	14.98	0.0	0.0	150	4.3
Y954H8	F82-546H3 x Y854	14738	48.74	15.11	0.0	0.0	159	3.9
9887H46	8906aa x RZM 8850...	14690	50.61	14.51	0.3	0.3	141	5.1
Y954H43	8743aa x Y854	14543	46.51	15.64	0.0	0.0	152	4.2
Y954H76	8776aa x Y854	14280	47.22	15.10	0.0	0.3	152	4.2
HH54	Holly (L543003)	13834	42.69	16.23	0.0	0.3	152	4.6
US H11	(7866442)	13375	48.06	13.88	0.0	0.0	167	5.9
MEAN		15164	49.59	15.30	0.1	0.1	152	4.5
LSD (.05)		1127	3.06	0.65	0.0	0.0	10	0.6
C.V. (%)		7.5	6.3	4.3	486.6	475.0	6.9	12.6
F value		2.9	3.7	4.0	1.4	0.9	4.7	9.5

TEST 2390. GCA EVALUATION OF GERMPLASM, SALINAS, CA., 1990

32 trmts X 8 reps, RCB
1-row plots, 30 ft. long

Planted: February 27, 1990
Harvested: September 27-28, 1990

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/ 100' No.	Avg PM Score
R970H20	87-309H3 x RZM R871-9	13926	48.16	14.46	0	.6	143	4.8
Y954H115	8857aa x Y854	13916	48.38	14.41	0	.7	142	3.9
9911H115	8857aa x 8911	13836	49.35	14.01	0	.3	133	4.0
R939/4H20	87-309H3 x R839C4	13696	48.04	14.29	0	.0	147	4.2
6625	Betaseed	13421	43.51	15.42	0	2.0	144	4.1
Y954H118	8855aa x Y854	13356	45.72	14.61	0	.3	138	3.9
9912H20	87-309H3 x RZM 8908-11	13116	45.84	14.29	0	.3	143	5.8
Y931/SH20	87-309H3 x Y731/S	12947	45.41	14.25	0	.0	144	4.7
Y931-43H20	87-309H3 x Y731-43	12719	45.49	13.92	0	.3	142	5.4
Y954H39	C762-17HO x Y854	12662	49.48	12.75	0	.6	139	4.0
Y949H20	87-309H3 x Y849	12656	44.75	14.13	0	.0	144	4.3
9910H20	87-309H3 x 8910	12649	45.72	13.82	0	.3	141	5.8
Y954H66	C766-23HO x Y854	12641	45.54	13.83	0	.0	144	3.8
Y954H40	C313CMS x Y854	12480	46.36	13.48	0	.6	139	3.1
Y954H122	8863aa x Y854	12462	44.57	14.02	0	.0	142	4.1
9911H20	87-309H3 x 8911	12436	43.19	14.36	0	.0	140	4.9
Y954H26	87-309CMS x Y854	12424	42.27	14.67	0	.0	148	5.4
Y954H70	C766-62HO x Y854	12143	45.47	13.34	0	1.0	141	3.9
Y954H18	88-790-68H26 x Y854	12047	43.30	13.89	0	.0	144	4.8
Y846H20	87-309H3 X Y746	11937	43.99	13.54	0	.3	147	4.5

TEST 2390. GCA EVALUATION OF GERMPLASM, SALINAS, CA., 1990

(continued)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/ 100' No.	Avg FM Score
Y954H54	C767-46HO x Y854	11836.	44.81	13.23	0	.0	139	3.6
Y954H50	8767-20HO x Y854	11826.	42.62	13.87	0	.0	148	3.7
Y954H89	88-790-68CMS x Y854	11797.	43.33	13.58	0	2.4	147	3.6
Y954H38	C312CMS x Y854	11734.	44.02	13.33	0	.0	146	3.4
Y954H113	8858aa x Y854	11716.	43.78	13.39	0	.3	148	4.3
9102H8	F82-546H3 x 8102 (C12T)	11661.	43.97	13.24	0	.0	144	3.9
Y954H20	87-309H3 x Y854	11600.	42.82	13.51	0	.0	148	5.0
Y954H52	8767-30HO x Y854	11512.	44.82	12.83	0	.4	137	3.5
HH54	Holly (L543003)	11171.	39.67	14.09	0	.0	141	4.8
Y954H8	F82-546H3 x Y854	10508.	41.27	12.70	0	.5	138	3.8
Y954H72	83-718HO x Y854	10369.	41.45	12.52	0	.0	139	3.6
US H11	C546H3 x C36	9889.	41.11	12.01	0	.3	149	5.3
MEAN		12284.	44.63	13.74	0	.3	143	4.3
LSD (.05)		1250.	3.8	.65	0	.9	0	.7
C.V. (%)		10.3	8.6	4.8	0	271.0	9.2	16.4
F value		5.0	3.0	9.17	0	2.8	.7	8.2

TEST 2490. EVALUATION OF RHIZOMANIA VARIETIES WITHOUT RHIZOMANIA, SALINAS, CA., 1990

8 trmts x 8 reps, RCB
1-row plots, 30 ft. long

Planted: April 17, 1990
Harvested: October 5, 1990

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Root Rot %	Beets/ 100' No.	RJAP %	Powdery Mildew Rating	Downey Mildew 6/18	Downey Mildew 7/2
Rima	SES (1989)	8757	28.04	15.69	0.0	139	82.0	6.6	1.5	3.2
R939C5	RZM R939C4 (C39R)	8745	29.80	14.74	0.0	128	83.2	2.2	2.2	3.8
R970	RZM R871-R879	8429	28.85	14.63	0.8	127	81.6	4.2	2.8	4.8
R947C5	RZM R847C4 (C47R)	8019	27.95	14.43	0.0	133	82.5	3.9	3.1	6.5
R922R	RZM R722 (C50)	7706	28.60	13.60	0.0	132	80.5	5.1	2.0	6.6
Rhizosen	Holly 49302 (12/88)	7546	27.33	13.85	0.0	133	84.2	5.3	0.9	3.8
R920	RZM R820 (C94)	7325	27.98	13.30	0.0	117	79.4	3.4	3.6	6.0
US H11	L78442	5709	22.73	12.43	0.0	143	82.6	5.8	3.1	5.2
MEAN		7780	27.66	14.08	0.1	131	82.0	4.6	2.4	5.0
LSD (.05)		1035	4.23	1.06	0.0	13	1.6	1.0	0.0	0.0
C.V. (%)		13.2	15.2	7.5	800.0	10.0	2.0	21.1	127.2	80.5
F value		7.5	2.0	7.2	1.0	2.9	6.8	17.6	0.7	0.9

TEST 1190. YIELD EVALUATION OF O.P. MULTIGERM GERMPLASM, SALINAS, CA., 1990

48 trmts x 5 reps 15 bl, RCB
1-row plots, 34 ft. long

Planted: February 13, 1990
Harvested: September 25-26, 1990

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Root Rot %	Beets/ 100' No.	RJAP %	Powdery Mildew Rating
Y931H89	88-790-68CMS x Y731	16637	54.33	15.33	0.8	171	85.0	3.2
R980	RZM 8244	16000	50.09	15.99	0.0	149	82.8	3.2
R947C5	RZM R847C4 (C47R)	15923	50.88	15.66	0.0	163	84.7	3.3
Y941	YR-ER-PMR Y741 (C91)	15449	48.13	16.08	0.4	152	83.3	2.7
Y947	YR-ER-PMR Y747 (C47)	15323	47.89	15.99	0.0	149	83.8	2.8
Y854	Inc. Y654	15168	48.69	15.57	0.0	144	82.5	3.5
U86-46/2	C46/2, 86342	15095	49.17	15.35	0.0	152	83.1	2.8
R975	Inc. R875	15057	47.14	15.97	0.0	146	82.1	3.5
9101	Inc. 8101 (C11T)	15007	47.29	15.86	0.0	141	84.1	2.6
Y949	Inc. Y849 (C49)	14989	47.33	15.87	0.0	145	83.7	2.6
R978C2	RZM R878	14955	48.48	15.39	0.0	144	82.7	2.9
Y956	YR-ER-PMR Y756,Y656	14898	47.05	15.89	0.0	164	82.8	3.4
R922Y	BYVR R722	14878	49.65	14.99	1.5	157	80.8	4.1
R977	RZM R877	14634	47.28	15.50	0.0	137	81.2	3.0
Y931-89	Inc. Y731-89	14575	46.31	15.81	0.0	148	82.3	2.4
9102	Inc. 8102 (C12T)	14477	44.34	16.35	0.0	137	86.6	2.9
F86-31/6	Inc. C31/6, 86263	14459	46.84	15.43	0.0	138	83.2	3.3
HH54	Holly (L543003)	14432	44.83	16.08	0.0	159	84.7	4.3
R939C5	RZM R839C4 (C39R)	14411	45.85	15.72	0.0	150	81.9	1.9
R903	RZM R803 (Alba)	14387	49.43	14.55	0.4	154	82.1	4.3

TEST 1190. YIELD EVALUATION OF O.P. MULTIGERM GERMPLASM, SALINAS, CA., 1990
(continued)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Root Rot %	Beets/ 100' No.	RJAP %	Powdery Mildew Rating
Y846	YR-ER-PMR Y646	14302	44.30	16.14	0.4	151	82.5	1.8
R976	RZM R876	14293	46.98	15.25	0.0	145	82.1	2.5
R970	RZM R871...R879	14292	48.48	14.79	0.0	133	82.7	3.9
Y954	Inc. Y854 (C54)	14291	46.08	15.55	0.4	143	83.7	2.9
Y931-43	Inc. Y731-43	14265	44.26	16.19	0.8	146	82.6	3.4
Y939	YR-ER-PMR Y739 (C39)	14131	43.30	16.38	0.0	149	81.7	2.2
R978C1	Inc. R878	14089	46.75	15.03	0.4	138	80.9	1.8
Y931-71	Inc. Y731-71	14044	45.50	15.55	0.0	141	83.0	2.3
Y948	YR-ER-PMR Y748 (C93)	13993	42.66	16.39	0.0	165	83.2	3.1
R922S	BYVR R722(%S)	13938	46.16	15.09	0.4	157	82.4	4.3
Y931/D	Inc. Y731-#(Davis)	13938	45.37	15.35	0.4	148	83.8	1.4
Y931	Inc. Y731 (Mass)	13920	45.10	15.42	0.0	143	83.4	3.2
R920	RZM R820 (C94)	13752	49.55	13.88	0.4	139	80.5	4.0
Y931/S	Inc. Y731-#(Salinas)	13749	44.83	15.35	0.0	151	82.6	2.5
R979	Inc. R879	13418	44.33	15.16	0.0	159	81.9	4.0
Y931-94	Inc. Y731-94	13325	42.37	15.78	0.0	144	83.7	1.7
R922R	RZM R722	13270	46.80	14.25	0.8	161	82.2	4.5
Y931-75	Inc. Y731-75	13210	42.88	15.46	0.4	136	83.8	1.5
Y931-10	Inc. Y731-10	12952	42.68	15.17	1.5	148	82.	

TEST 1190. YIELD EVALUATION OF O.P. MULTIGERM GERMPLASM, SALINAS, CA., 1990
(continued)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Root Rot %	Beets/ 100' No.	RJAP %	Powdery Mildew Rating
R925	RZM R825	11468	39.53	14.52	0.0	155	80.1	4.5
SP76622-0	L80466 (8/87)	11347	39.45	14.32	0.0	155	82.6	4.1
R928C1	RZM 8228	9902	37.88	13.10	0.4	152	80.3	4.8
R904	RZM Rovigo Acc.	9107	38.92	11.80	0.0	158	80.3	4.3
MEAN		13902	45.55	15.26	0.2	150	82.6	3.2
LSD (.05)		1626	5.52	0.93	0.9	15	2.4	1.0
C.V. (%)		9.4	9.7	4.9	298.9	7.9	2.3	26.0
F value		6.3	3.0	7.1	1.4	2.9	2.4	7.1

TEST 1290. YIELD EVAL OF SELF-FERTILE MULTIGERM & MONOGERM, SALINAS, CA., 1990

24 trmts x 5 reps 15 bl, RCB
1-row plots, 34 ft. long

Planted: February 13, 1990
Harvested: September 26, 1990

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Root Rot %	Beets/ 100' No.	Powdery Mildew Rating
9911H49	7903aa x 8911	15889	50.53	15.75	0.0	152	3.7
N902-3H46	8906aa x 8203,4,5	15637	57.29	13.69	0.0	151	5.4
8909	7909,7239aa x A	15596	50.05	15.59	0.0	144	4.3
9910H47	5747aa x 8910	15589	51.86	15.06	0.9	142	5.0
R939/4H44	8904aa x R839C4	15512	49.82	15.55	0.0	153	2.8
9102	Inc. 8102 (C12T)	15247	44.64	17.11	0.0	145	3.4
Y954	Inc. Y854 (C54)	15192	48.67	15.58	0.4	139	3.9
5747	4747aa x A	15164	53.26	14.23	0.4	138	4.8
9910	8910aa x A	14915	51.93	14.36	0.0	159	4.6
9912	RZM 8908,9,10,11aa x A	14893	49.16	15.11	0.4	148	4.6
9887H86	8787aa x RZM 8850-63	14891	49.68	14.99	0.4	159	4.8
9903	YR-ER-PRM 7903 (A,aa)	14871	47.79	15.58	0.0	162	3.7
8906	RZM 7906,7aa x A	14761	52.48	14.08	0.8	146	4.8
9887m	RZM 8850-63mmaa x A	14678	47.84	15.34	0.8	151	5.2
9911	8911aa x A	14618	45.95	15.93	0.4	149	3.6
9867m	8852,7mmaa x A	14598	48.58	15.05	0.9	149	5.7
9876m	8860,1,2,3mmaa x A	14526	48.64	14.95	0.4	150	5.4
9876H76	8776aa x 8860,1,2,3	14418	46.98	15.36	0.0	158	4.7
9867H67	8767aa x 8852,7	14232	47.73	14.93	0.0	157	4.7
9866H80	8755aa x 8853,5,6	14161	45.81	15.47	0.0	152	4.2

TEST 1290. YIELD EVAL OF SELF-FERTILE MULTIGERM & MONOGERM, SALINAS, CA., 1990

(continued)

Variety	Description	Acre Yield		Sucrose	Root Rot	Beets/ 100'	Powdery Mildew
		Sugar Lbs	Beets Tons	%	%	No.	Rating
9859M	8850,1,4,8(M)aa x A	13715	46.23	14.84	1.2	144	6.1
9905	YR-ER-PMR 7905 (A,aa)	12387	42.07	14.72	0.7	156	4.3
U86-37	C37, 86443	12197	41.34	14.76	0.0	161	5.0
R929C1	RZM 8229	11300	41.91	13.44	0.8	142	4.2
MEAN		14541	48.34	15.06	0.4	150	4.5
LSD (.05)		1418	4.19	0.89	0.0	13	0.9
C.V. (%)		7.8	6.9	4.7	254.7	6.9	16.5
F value		5.1	6.3	6.0	0.9	2.2	5.4

TEST 590. PROGENY TEST OF LINES FROM MM,S^f,A:aa-popn, SALINAS, CA., 1990

16 entries x 8 reps, RCB
1-row plots, 30 ft. long

Planted: February 12, 1990
Harvested: September 11, 1990

Variety	Description	Acre Yield		Sucrose	Bolters	Root Rot	Beets/ 100'	Powdery Mildew
		Sugar Lbs	Beets Tons	%	%	%	No.	Avg.
9908-7H26	87-309CMS x 7908-7	16258	47.01	17.30	0.0	0.0	167	6.1
9907-21H26	87-309CMS x 7907-21	15450	48.19	16.04	0.0	0.0	160	7.3
9867H28	6235-14aa x 8852,7	14901	46.94	15.88	0.0	0.7	133	3.6
9909-16H26	87-309CMS x 8909-16	14845	44.83	16.54	0.3	0.0	159	6.1
9911H26	87-309CMS x 8911	14788	44.50	16.61	0.0	0.0	165	5.8
9908-2H26	87-309CMS x 8908-2	14712	45.34	16.23	0.0	0.0	170	6.4
9867H46	8906aa x 8852,7	14694	47.63	15.43	0.3	0.3	150	5.3
9867H29	6235-21aa x 8852,7	14677	49.47	14.82	0.2	0.0	162	5.3
9867H33	6237-14aa x 8852,7	14670	47.91	15.27	1.1	0.0	153	4.4
9867H30	7908-2aa x 8852,7	14599	46.61	15.68	0.0	0.0	145	4.6
9867H34	6237-16aa x 8852,7	14595	45.59	16.01	0.0	0.0	154	5.0
9867H32	6237-13aa x 8852,7	14530	47.17	15.40	0.0	0.0	150	5.0
9867H31	6236-7aa x 8852,7	14255	45.82	15.56	0.0	0.0	135	4.8
9909-14H26	87-309CMS x 8909-14	14191	43.92	16.17	0.0	0.0	119	6.5
9909-13H26	87-309CMS x 8909-13	14004	42.94	16.33	0.0	0.0	157	5.4
9907-14H26	87-309CMS x 7907-14	13692	43.13	15.89	0.0	0.0	144	7.1
MEAN		14679	46.06	15.95	0.1	0.1	151	5.5
LSD (.05)		955	2.28	0.69	0.4	0.0	11	0.8
C.V. (%)		6.6	5.0	4.4	367.3	859.9	7.5	14.1
F value		2.9	5.3	5.9	3.4	1.0	11.6	13.0

TEST 2290. RETEST OF PROGENY LINES FROM POPN - 776 & POPNS 907-909, SALINAS, CA., 1990

16 trmts X 8 reps, RCB
1-row plots, 30 ft. long

Planted: February 27, 1990
Harvested: October 9, 1990

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	SUCROSE %	ROOT ROT %	Beets/ 100' No.	Avg PM Score
9907-14H26	87-309CMS x 7907-14	15081	45.07	16.73	.0	154	5.4
9867H29	6235-21aa x 8852,7	14999	52.02	14.43	.0	144	6.0
9867H30	7908-2aa x 8852,7	14494	47.83	15.15	.0	141	5.9
9867H46	8906aa x 8852,7	14405	49.12	14.66	.3	140	5.3
9867H32	6237-13aa x 8852,7	14326	48.99	14.66	.7	137	5.4
9867H34	6237-16aa x 8852,7	14140	46.02	15.36	.3	138	5.3
4757	Betaseed	13630	45.01	15.13	.3	151	2.9
9867H33	6237-14aa x 8852,7	13538	45.65	14.84	.0	133	3.9
Y954H54	C767-46HO x Y854	13479	44.34	15.18	.0	137	4.0
9867H31	6236-7aa x 8852,7	12907	44.92	14.38	.3	129	5.0
Y954H76	8776aa x Y854	12854	42.56	15.11	.0	143	3.6
Y954H59	7776-21aa x Y854	12548	43.53	14.43	.0	146	3.3
Y954H60	7776-25aa x Y854	12031	40.64	14.81	.3	133	3.8
Y954H57	7776-1aa x Y854	11726	39.44	14.86	.5	144	3.9
HH54	Holly (L543003)	11573	37.74	15.33	.3	147	4.4
Y954H58	7776-20aa x Y854	10991	38.51	14.21	.0	143	3.9
MEAN		13295	44.46	14.95	.2	141	4.5
LSD (.05)		965.0	3.0	0.56	.0	12	0.7
C.V. (%)		7.3	6.7	3.7	396.9	8.4	15.8
F value		13.5	14.3	8.9	.7	2.5	14.5

TEST 790. CODED VARIETY TRIAL: AREA 4, SALINAS, CA., 1990

32 entries X 8 reps, RCB
1-row plots, 30 ft. long

Planted: February 12, 1990
Harvested: September 17, 1990

Code	Variety	Source	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/ 100' No.	PM Score Avg.
Y954H39	6762-17HO x Y854	USDA	15430	52.85	14.61	0.0	1.1	153	3.8
4F-15	86C15-014	Holly	15361	47.52	16.17	0.0	0.5	160	5.1
4F-10	USC4	Holly	15258	48.72	15.65	0.0	0.0	154	4.8
4F-28	7BH6103	Beta	15120	49.29	15.31	0.0	0.8	155	3.3
4F-8	8BG6169	Beta	15018	47.50	15.82	0.0	0.0	165	4.9
4F-14	88-1459-049	Holly	15012	47.59	15.77	0.0	0.0	157	4.7
Y954H70	7766-62HO x Y854	USDA	14985	49.79	15.05	0.0	0.0	138	4.1
4F-24	4581	Beta	14961	48.55	15.44	1.7	0.6	154	4.6
4F-26	SSNB3	Spreckels	14818	48.24	15.37	0.0	0.3	144	3.8
4F-22	Hill-2	H-MH	14739	46.74	15.77	0.0	0.0	149	3.8
4F-6	H87545	Spreckels	14726	47.39	15.53	0.3	0.0	162	4.8
4F-2	86-84C65-05	Holly	14718	45.59	16.14	0.3	0.0	159	4.3
4F-4	7BG6092	Beta	14689	48.08	15.29	0.0	0.0	151	3.2
4F-12	HH66	Holly	14684	47.03	15.63	0.0	0.0	162	5.4
4F-7	HH41	Holly	14676	48.78	15.04	0.0	0.0	159	4.6
4F-27	HB8242	Spreckels	14631	47.22	15.51	0.0	0.0	164	5.2
4F-9	HH37	Holly	14625	48.26	15.16	0.0	0.0	158	4.5
9102H8	F82-546H3 x 8102	USDA	14606	47.43	15.40	0.0	0.3	150	4.0
4F-18	85C62-016	Holly	14569	48.29	15.08	0.0	0.0	146	4.4
4F-25	6BG6209	Beta	14562	48.51	15.00	0.0	0.6	151	5.0

TEST 790. CODED VARIETY TRIAL: AREA 4, SALINAS, CA., 1990
(continued)

Code	Variety	Source	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/ 100' No.	PM Score Avg.
4F-19	H86558	Spreckels	14534	46.13	15.77	0.0	0.0	155	4.3
4F-1	86-84C25-020	Holly	14506	48.89	14.84	0.0	0.0	145	4.9
Y954H54	8767-46HO x Y854	USDA	14497	48.33	15.00	0.0	0.0	142	4.3
4F-20	USC-5	Holly	14381	45.92	15.68	0.0	0.0	159	5.1
4F-16	4757	Beta	14075	44.34	15.88	0.3	0.3	151	3.8
4F-11	SS-NB2	Spreckels	14069	45.50	15.46	0.0	0.6	152	4.9
4F-3	SS-Z2	Spreckels	13992	43.58	16.08	0.0	0.0	158	4.5
4F-17	Rhizosen	Holly	13977	47.10	14.85	0.0	0.3	155	4.6
4F-21	84C39-029	Holly	13713	42.94	15.96	0.0	0.3	154	4.3
4F-13	HH54	Holly	13691	42.75	16.01	0.0	0.0	155	4.6
4F-5	SS-Z1	Spreckels	13590	44.86	15.15	0.0	0.0	154	5.1
4F-23	4480	Beta	13539	42.54	15.89	0.0	0.2	160	4.6
MEAN			14555	47.07	15.48	0.1	0.2	154	4.5
LSD (.05)			879	2.38	0.51	0.4	0.6	11	0.6
C.V. (%)			6.1	5.1	3.3	538.5	355.9	7.1	13.6
F value			2.5	6.9	5.3	4.1	1.6	2.7	6.5

TEST 790. CODED VARIETY TRIAL: AREA 4, SALINAS, CA., 1990
(continued)

Code	Sodium PPM	Potassium PPM	Amino Nitrogen PPM	Impur. Value	Impur. Index	Known Sugar Loss Acre	Recover. Sugar Acre	Recover. Sugar %	Recover. Sugar Lbs/Ton
Y954H39	463.80	1478.40	327.79	8433.29	578.13	1337.93	14092.34	91.33	266.83
4F-15	416.70	1293.36	338.36	7906.28	489.44	1127.08	14234.34	92.66	299.78
4F-10	357.59	1475.52	419.59	8926.41	572.29	1300.69	13957.04	91.41	286.22
4F-28	357.59	1433.22	339.32	8058.16	530.89	1189.90	13929.61	92.04	281.95
4F-8	390.27	1510.61	399.88	8941.31	569.37	1275.52	13742.37	91.46	289.55
4F-14	386.42	1173.21	324.42	7367.50	468.84	1054.79	13956.90	92.97	293.27
Y954H70	355.66	1552.42	325.38	8217.01	547.88	1227.49	13757.53	91.78	276.35
4F-24	405.17	1469.27	333.55	8260.02	538.13	1204.31	13756.59	91.93	283.97
4F-26	435.45	1407.27	319.62	8078.59	526.13	1176.93	13641.38	92.11	283.14
4F-22	462.84	1462.54	416.22	9230.40	587.18	1290.52	13448.21	91.19	287.68
4F-6	380.17	1274.62	400.84	8325.15	536.15	1187.78	13537.99	91.96	285.65
4F-2	360.47	1390.45	334.03	7911.09	492.11	1086.62	13631.10	92.62	299.14
4F-4	425.35	1433.22	379.22	8674.32	568.57	1255.11	13434.35	91.47	279.73
4F-12	360.95	1339.02	323.46	7683.75	491.55	1084.40	13599.38	92.63	289.45
4F-7	337.40	1247.70	325.39	7391.29	492.26	1084.43	13591.95	92.62	278.70
4F-27	398.92	1297.21	375.37	8205.23	530.45	1163.89	13466.89	92.04	285.51
4F-9	414.78	1067.95	290.30	6879.43	454.50	1003.39	13621.86	93.18	282.61
9102H8	480.15	1203.48	294.14	7483.57	486.70	1067.62	13538.28	92.70	285.55
4F-18	492.64	1339.50	373.93	8625.30	573.14	1246.84	13322.19	91.40	275.75
4F-25	377.29	1341.42	331.15	7820.01	522.35	1147.69	13414.66	92.16	276.54
4F-19	362.39	1338.54	302.80	7491.26	475.68	1037.28	13496.46	92.87	292.90
4F-1	495.52	1234.25	273.48	7417.97	501.85	1089.75	13416.69	92.47	274.49
Y954H54	437.85	1499.07	373.93	8832.44	592.87	1279.71	13217.11	91.11	273.50
4F-20	342.20	1421.21	417.66	8718.54	557.11	1205.37	13175.44	91.64	287.34

TEST 790. CODED VARIETY TRIAL: AREA 4, SALINAS, CA., 1990
(continued)

Code	Sodium PPM	Potassium PPM	Amino Nitrogen PPM	Impur. Value	Impur. Index	Known Sugar Loss Acre	Recover. Sugar Acre	Recover. Sugar %	Recover. Sugar Lbs/Ton
4F-16	529.17	1081.41	313.85	7537.16	475.72	1000.94	13073.65	92.86	295.01
4F-11	412.86	1332.29	385.94	8442.18	547.01	1155.47	12913.45	91.79	283.80
4F-3	275.88	1400.06	468.61	8917.52	555.21	1170.02	12822.01	91.67	294.75
4F-17	453.23	1091.02	224.93	6450.71	436.77	913.42	13063.53	93.45	277.65
4F-21	367.68	1283.75	315.29	7491.50	469.82	967.58	12745.24	92.95	296.65
4F-13	354.22	1002.10	224.45	5877.32	368.74	755.93	12934.84	94.47	302.49
4F-5	496.49	1288.56	423.91	8986.25	595.31	1211.78	12377.90	91.07	276.04
4F-23	507.06	1046.80	272.99	6985.16	441.29	893.42	12645.99	93.38	296.80
MEAN	409.19	1319.05	342.81	7986.44	517.92	1131.05	13423.66	92.23	285.59
LSD (.05)	124.18	123.54	57.56	861.40	61.73	140.27	845.17	0.93	10.88
C.V. (%)	30.8	9.5	17.0	10.9	12.1	12.6	6.4	1.0	3.9
F value	1.80	11.05	7.60	6.50	5.80	6.87	2.06	5.80	5.08

TEST 1090. PROGENY TEST OF LINES FROM C31/6 AND PoPn-776, SALINAS, CA., 1990

16 entries x 8 reps, RCB
1-row plots, 30 ft. long

Planted: February 12, 1990
Harvested: September 14, 1990

Variety	Description	Acre Yield Sugar lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Root Rot %	Beets/ 100' No.	Powdery Mildew Avg.
Y931H20	87-309H3 x Y731	15116	49.48	15.26	0.0	0.3	152	4.4
Y931-43H20	87-309H3 x Y731-43	14955	47.59	15.69	0.0	0.0	151	5.4
Y931-89H20	87-309H3 x Y731-89	14847	47.56	15.61	0.0	0.0	159	4.4
Y931-10H20	87-309H3 x Y731-10	14640	48.36	15.10	0.0	0.0	155	4.1
Y954H59	7776-21aa x Y854	14495	47.49	15.26	0.0	0.0	158	4.4
Y954H57	7776-1aa x Y854	14405	46.45	15.51	0.0	0.0	154	4.3
Y931/SH20	87-309H3 x Y731/S	14402	46.56	15.46	0.0	0.4	148	4.6
Y931-71H20	87-309H3 x Y731-71	14401	46.10	15.59	0.0	0.3	151	4.2
Y954H76	8776aa x Y854	14369	46.26	15.54	0.0	0.0	151	4.2
Y931/DH20	87-309H3 x Y731/D	14233	45.71	15.56	0.0	0.0	157	4.3
Y931-75H20	87-309H3 x Y731-75	14210	46.43	15.25	0.0	0.3	159	4.9
Y731H20	86-309H3 x F86-31/6	14151	46.06	15.34	0.0	0.0	154	4.5
Y954H60	7776-25aa x Y854	13919	45.83	15.16	0.0	0.0	154	3.8
Y931-94H20	87-309H3 x Y731-94	13868	44.90	15.43	0.0	0.2	161	4.4
HH54	Holly (L543003)	13495	40.61	16.61	0.3	0.0	156	4.6
Y954H58	7776-20aa x Y854	13265	45.27	14.65	0.0	0.0	159	3.9
MEAN		14298	46.29	15.44	0.0	0.1	155	4.4
LSD (.05)		1029	2.61	0.57	0.0	0.0	0	0.5
C.V. (%)		7.3	5.7	3.8	1131.4	527.8	6.8	11.3
F value		1.8	4.3	3.9	1.0	0.7	1.0	4.4

TEST 90A. BYV INOCULATED vs. NONINOCULATED
EVALUATION OF C31 SYNTHETICS & LINES, 1990
(DAVIS, CA)

16 entries x 6 reps x 2 virus trtmts[1]
1-row plots, 30 ft. long

Planted: May 9, 1990
Inoculated: June 19, 1990
Harvested: October, 1990

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %
Checks				
4757	Betaseed	8,459	31.21	13.5
SS NB3	Spreckels	8,051	29.90	13.5
HH46	Holly	7,725	28.43	13.6
Y954	Inc. Y854 (C54)	7,592	28.69	13.2
768	Inc. 868 (US 75)	5,916	24.47	12.1
SP7622-0	Inc. SP22-0	4,993	19.67	12.7
Synthetics of C31/6				
Y931D	Inc. Y731-HS (Davis)	8,363	30.29	13.8
F86-31/6	Inc. C31/6 (86263)	8,290	28.47	14.6
Y931S	Inc. Y731-HS (Salinas)	8,173	29.65	13.8
Y931	Inc. Y731 (Mass)	8,159	29.86	13.6
Half-sib increases				
Y931-89	Inc. Y731-89	8,199	29.32	14.1
Y931-43	-43	8,157	27.65	14.8
Y931-10	-10	8,099	28.71	14.1
Y931-94	-94	8,097	29.10	13.9
Y931-71	-71	8,075	29.24	13.8
Y931-75	-75	8,046	28.54	14.1
Mean Noninoculated		7,884	28.89	13.8
Mean Inoculated		7,665	27.76	13.6
LSD (.05)		1,005	2.8	0.01
CV (%)		11.2	8.6	6.9
F value for varieties		10.2**	11.1**	4.8**
F value for virus treatment		3.0NS	10.4**	1.3NS
F value for variety x virus		3.3**	3.1**	1.8*

Note: Test conducted by Dr. Steve Temple, U.C. Davis.
Corresponds to Salinas test 2190 except for 3 check hybrids.

[1] Effects of BYV inoculation were very mild. Test summarized over both treatments.

TEST 90B. BYV INOCULATED EVALUATION OF HYBRIDS OF C31 SYNTHETICS & LINES, 1990 (DAVIS, CA)

16 entries, 6 reps, RCB
1-row plots, 30 ft. long

Planted: May 9, 1990
Inoculated: June 20, 1990
Harvested: October, 1990

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %
Checks				
4757	Betaseed	8,297	31.91	13.0
HH46	Holly	7,326	28.57	12.8
SSNB3	Spreckels	7,166	29.88	12.0
9102H8	F82-546H3 x 8102	6,969	26.37	13.2
US H11	C546H3 x C36	6,809	28.17	12.1
Y954H20	87-309H3 x Y854	6,754	26.61	12.7
Hybrids with synthetics				
Y931DH20	87-309H3 x Y731D	7,546	29.34	12.9
Y931H20	87-309H3 x Y731	7,486	29.13	12.8
Y731H20	86-309H3 x F86-31/6	7,235	28.95	12.5
Y931SH20	87-309H3 x Y731S	7,041	28.42	12.4
Hybrids with HS-lines				
Y931-43H20	87-309H3 x Y731-43	7,765	29.82	13.0
Y931-10H20	87-309H3 x Y731-10	7,573	27.95	13.6
Y931-89H20	87-309H3 x Y731-89	7,443	28.76	12.9
Y931-94H20	87-309H3 x Y731-94	7,235	28.11	12.9
Y931-75H20	87-309H3 x Y731-75	7,189	27.55	13.1
Y931-71H20	87-309H3 x Y731-71	7,111	27.21	13.1
Mean		7,309	28.55	12.8
LSD (.05)		NS	NS	0.8
CV (%)		11.1	8.9	5.4
F value		1.3NS	1.8NS	2.1*

Note: Test conducted by Dr. Steve Temple, U.C. Davis.
Test corresponds with Salinas test 1690. Solid inoculation with BYV. However, effects of virus appeared to be very mild.

[1] 87-309H3 = C562CMS x C309; F82-546H3 = C562CMS x C309. Y854 = C54. 8102 = C12T. F86-31/6 = C31/6.

TEST 90C. BYV INOCULATED EVALUATION OF
HYBRIDS WITH C31 SYNTHETICS, 1990.
(DAVIS, CA)

16 entries, 6 reps, RCB
1-row plots, 30 ft. long

Planted: May 9, 1990
Inoculated: June 21, 1990
Harvested: October, 1990

Variety	Description	Acre Yield Sugar Lbs	Beets Tons	Sucrose %
Checks				
4757	Betaseed	7,997	30.43	13.2
HH46	Holly	7,647	29.31	13.0
SSNB3	Spreckels	7,193	28.69	12.5
C790-68CMS				
Y931H89	C790-68CMS x Y731	8,155	29.32	13.9
Y931SH89	C790-68CMS x Y731-Salinas	7,939	29.47	13.5
Y731H89	C790-68CMS x F86-31/6	8,110	30.41	13.4
Y931DH89	C790-68CMS x Y731-Davis	7,553	29.32	12.9
Popn-776 x C31 synthetics				
Y931DH77	7776HO x Y931-Davis	7,935	31.04	12.8
Y931H77	7776HO x Y731	7,545	29.61	12.7
Y731H77	5776HO x F86-31/6	7,239	28.69	12.6
Y931SH77	7776HO x Y931-Salinas	7,165	28.74	12.5
Popn-776 lines x C54				
Y954H57	7776-1aa x Y854	7,598	27.48	13.8
Y954H59	7776-21aa x Y854	7,539	28.71	13.1
Y954H58	7776-20aa x Y854	7,431	27.93	13.3
Y954H60	7776-25aa x Y854	7,055	26.02	13.6
Y954H76	8776aa x Y854	7,054	26.91	13.1
Mean		7,572	28.88	13.1
LSD (.05)		665.7	2.4	0.8
CV (%)		7.6	7.1	5.6
F value		2.5**	2.4**	2.1*

Note: Test conducted by Dr. Steve Temple, U.C. Davis.
Test corresponds to Salinas test 1590. Solid inoculation with BYV. However, effects of virus appeared to be very mild.

[1] 7776-#'s = half-sib lines from popn-776 selected for resistance to BYV.

TEST 1490. NONINOCULATED PERFORMANCE OF EXPERIMENTAL HYBRIDS, SALINAS, CA., 1990

Split-block with 4 replications
32 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: February 28, 1990
Harvested: October 17-19, 1990
Not Inoculated[1]

Variety	Description[4]	Acre Yield Sugar	Acre Yield Beets	Sucrose	Root Rot[2]	Beets/ 100'[2]	RJAP	Powdery Mildew[2,3]
		Lbs	Tons	%	%	No.	%	Rating
4757	Betaseed	16963	55.09	15.40	0.3	157	85.0	5.4
9102H8	F82-546H3 x 8102 (C12T)	16316	51.19	15.94	0.6	152	86.6	5.5
Y954H70	C766-62HO x Y854	16026	52.83	15.18	0.3	156	84.8	5.9
Y731H42	C742-24HO x F86-31/6	15966	52.32	15.25	0.0	156	87.1	4.5
9911H68	7767HO x 8911	15953	53.02	15.05	0.0	151	85.5	6.0
Y931H39	C762-17HO x Y731	15870	55.85	14.19	1.1	150	84.5	4.8
Y954H39	C762-17HO x Y854	15820	52.79	14.99	0.0	154	86.2	5.1
Y949H68	7767HO x Y849	15778	50.45	15.64	0.0	153	85.8	4.3
R970H68	7767HO x RZM R871-79	15679	52.60	14.90	0.0	150	84.0	5.5
Y931H89	88-790-68CMS x Y731	15652	51.79	15.14	0.3	165	85.0	4.7
Y731H67	6767aa x F86-31/6	15617	52.26	14.94	0.0	157	84.8	4.4
Y931H20	87-309H3 x Y731	15554	50.54	15.39	0.3	158	86.1	5.7
Y846H68	7767HO x Y746	15484	51.82	14.96	0.0	149	84.5	4.5
R939/4H68	7767HO x R839C4	15445	50.51	15.30	0.3	153	84.7	4.4
Y954H122	8863aa x Y854	15428	49.07	15.73	0.3	147	85.6	5.8
Y954H86	8787aa x Y854	15349	52.11	14.76	0.3	155	84.2	5.3
9912H68	7767HO x RZM 8908-11	15320	51.63	14.84	0.0	150	83.5	6.1
Y931SH18	88-790-68H26 x Y731-S	15260	50.65	15.06	0.0	166	85.1	5.9
Y931H77	7776HO x Y731	15258	52.67	14.48	0.0	157	85.4	5.1
Y954H54	C767-46HO x Y854	15112	49.54	15.27	0.0	153	84.5	5.1

TEST 1490. NONINOCULATED PERFORMANCE OF EXPERIMENTAL HYBRIDS, SALINAS, CA., 1990
(continued)

Variety	Description[4]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Root Rot[2] %	Beets/ 100'[2] No.	RJAP %	Powdery Mildew[2,3] Rating
Y954H18	88-790-68H26 x Y854	15002	47.96	15.64	0.0	158	84.6	7.1
Y954H115	8857aa x Y854	14909	49.38	15.11	0.0	159	84.6	5.8
HH54	Holly	14888	45.42	16.40	0.0	153	88.0	6.6
Y954H67	8767aa x Y854	14734	49.84	14.77	0.0	160	83.6	5.4
9910H68	7767HO x 8910	14661	49.42	14.81	0.3	144	85.4	5.9
Y954H52	8767-30HO x Y854	14607	48.70	15.00	0.0	150	85.1	5.3
Y954H76	8776aa x Y854	14448	48.63	14.88	0.0	152	84.9	5.3
Y954H8	F82-546H3 x Y854 (C54)	14191	49.59	14.27	0.0	160	85.5	6.1
9101H8	F82-546H3 x 8101 (C11T)	13997	46.42	15.02	0.0	157	88.9	5.4
Y954H50	8767-20HO x Y854	13836	46.21	14.99	0.0	163	83.3	5.3
SSNB3	Spreckels	12792	44.70	14.30	0.0	153	87.6	7.1
US H11	C546H3 x C36	12417	45.55	13.64	0.0	158	83.2	8.1
MEAN		15135	50.33	15.04	0.1	155	85.2	5.5
LSD (.05)		1455	4.41	0.80	NS	NS	1.8	0.6
C.V. (%)		6.8	6.20	3.80	450.1	6.5	1.5	11.1
F value		3.3	2.98	3.47	1.6NS	1.4NS	4.2	14.6**

[1]BYV inoculated and % loss are summarized on the following page.
[2]Means over both virus treatments.
[3]PM rating 8/23/90 and 9/5/90.
[4]HO = CMS; aa = genetic ms.

TEST 1490. BYV INOCULATED PERFORMANCE OF EXPERIMENTAL HYBRIDS, SALINAS, CA., 1990

Split-block with 4 replications
32 entri.. .. 2 virus treatments
1-row plots, 30 ft. long

Planted: February 28, 1990
Harvested: October 17-19, 1990
BYV Inoculated: May 15, 1990

Variety	Description	Sugar Yield Inoc. Lbs/A	Sugar Yield Loss %	Beets Yield Inoc. Tons	Beets Yield Loss %	Sucrose Inoc. %	Sucrose Loss %	RJAP %	Mean Yellows[5] Rating
Y731H42	C742-24HO x F86-31/6	12456	21.3	42.08	18.9	14.80	2.9	86.1	5.1
Y931SH18	88-790-68H26 x Y731-S	11965	21.6	38.97	23.0	15.34	-1.8	84.2	6.3
Y731H67	6767aa x F86-31/6	11696	25.3	39.89	23.8	14.64	2.0	84.9	4.8
Y931H77	7776HO x Y731	11660	23.2	40.17	23.5	14.50	-0.3	84.8	6.0
Y931H89	88-790-68CMS x Y731	11446	26.8	39.46	23.4	14.43	4.6	84.4	5.1
Y949H68	7767HO x Y849	11416	27.5	39.46	21.6	14.49	7.4	85.2	5.3
R939/4H68	7767HO x R839C4	11199	27.4	39.11	22.2	14.31	6.3	84.3	5.0
Y931H20	87-309H3 x Y731	11080	28.6	37.45	25.8	14.77	3.9	84.9	6.5
9910H68	7767HO x 8910	11044	24.0	39.29	20.2	14.07	4.8	85.0	6.3
Y931H39	C762-17HO x Y731	10920	30.8	40.87	26.6	13.35	5.8	84.1	5.4
9912H68	7767HO x RZM 8908-11	10863	29.0	37.42	27.4	14.50	2.3	84.8	6.8
Y954H76	8776aa x Y854	10716	25.3	36.29	24.9	14.77	0.5	83.1	5.8
R970H68	7767HO x RZM R871-79	10586	32.1	36.21	31.0	14.60	2.0	83.3	6.0
Y954H86	8787aa x Y854	10478	31.8	36.89	29.1	14.24	3.3	84.6	5.9
Y954H67	8767aa x Y854	10478	29.2	35.17	29.5	14.84	-0.4	84.4	6.1
9911H68	7767HO x 8911	10458	34.2	35.97	31.9	14.54	3.3	83.9	7.3
Y954H52	8767-30HO x Y854	10452	28.4	37.66	22.7	13.91	7.3	84.7	5.9
Y954H18	88-790-68H26 x Y854	10148	32.1	33.99	28.9	14.93	4.5	85.5	7.8
Y954H115	8857aa x Y854	10141	31.6	35.22	28.2	14.40	4.7	83.9	6.6
Y846H68	7767HO x Y746	10057	35.0	35.55	31.4	14.13	5.2	83.4	5.4

TEST 1490. BYV INOCULATED PERFORMANCE OF EXPERIMENTAL HYBRIDS, SALINAS, CA., 1990
(continued)

Variety	Description	Sugar Yield Inoc.	Sugar Yield Loss	Beets Yield Inoc.	Beets Yield Loss	Sucrose Inoc.	Sucrose Loss	RJAP	Mean Yellows[5]
		Lbs/A	%	Tons	%	%	%	%	Rating
4757	Betaseed	10013	40.9	34.33	37.6	14.56	5.4	84.5	6.5
Y954H122	8863aa x Y854	10008	35.2	36.03	26.6	13.88	11.7	84.8	6.1
Y954H54	C767-46HO x Y854	9989	33.6	34.66	29.3	14.39	5.7	84.2	6.0
Y954H70	C766-62HO x Y854	9895	38.1	34.60	34.4	14.30	5.7	85.2	3.3
Y954H39	C762-17HO x Y854	9719	38.3	36.81	30.1	13.21	11.7	86.0	3.2
US H11	C546H3 x C36	9058	27.3	32.71	28.1	13.80	-1.4	85.2	3.2
Y954H50	8767-20HO x Y854	8864	35.9	32.04	30.6	13.84	7.6	84.0	3.2
Y954H8	F82-546H3 x Y854 (C54)	8842	37.1	31.30	36.8	14.09	0.9	84.2	3.8
9102H8	F82-546H3 x 8102 (C12T)	8778	46.0	30.81	39.6	14.26	10.5	85.0	3.9
SSNB3	Spreckels	8682	31.6	32.11	28.1	13.54	5.1	82.8	3.8
9101H8	F82-546H3 x 8101 (C11T)	8384	39.6	30.58	33.9	13.70	8.7	85.7	3.8
HH54	Holly	8282	44.3	28.04	38.2	14.76	10.0	85.6	3.8
MEAN		10305	31.7	35.97	28.4	14.31	4.7	84.6	3.3
LSD (.05)		1222	10.3	3.61	9.5	0.85	7.7	0.0	0.6
C.V. (%)		8.40	23.3	7.10	23.9	4.20	117.6	1.70	2.8
F value for varieties		6.5**	2.9**	7.2**	2.5**	4.2**	1.7*	3.8**	2.8**
F value for virus treatments		927.6**	--	669.9**	--	101.8**	--	5.9**	--
F value for variety x virus		2.5**	--	1.9**	--	1.7*	--	1.6*	--

[5]Mean virus yellows scores from 6/22, 6/28 and 7/6/90. Scored from 0 = no symptoms to 9 = 100% of matured leaf canopy yellowed.

TEST 1590. NONINOCULATED EVALUATION OF HYBRIDS WITH SYNTHETICS OF C31 & C54, SALINAS, CA., 1990

Split-block with 4 replications
16 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: February 28, 1990
Harvested: October 16, 1990
Not Inoculated[1]

Variety	Description[4]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Root Rot[2] %	Beets/ 100'[2] No.	RJAP %	Powdery Mildew[2,3] Rating
Y931DH77	7776HO x Y731/D	15478	55.02	14.06	0.3	156	84.8	4.2
4757	Betaseed	15155	52.00	14.57	0.0	164	83.6	4.1
Y731H77	5776HO x F86-31/6	14875	53.18	13.96	0.0	150	84.2	4.4
Y954H76	8776aa x Y854	14526	48.24	15.07	0.0	157	83.9	4.5
Y931SH89	C790-68CMS x Y731/S	14298	50.04	14.27	0.5	156	84.1	3.8
Y954H59	7776-21aa x Y854	14169	49.44	14.32	0.0	157	84.3	4.4
Y731H89	C790-68CMS x F86-31/6	14114	50.11	14.09	1.7	153	83.9	4.1
Y931SH77	7776HO x Y931/S	13934	50.25	13.84	0.5	157	84.3	4.3
Y954H60	7776-25aa x Y854	13660	48.37	14.10	0.0	158	84.5	4.3
Y931H77	7776HO x Y731	13295	47.83	13.86	0.0	160	83.9	4.3
Y954H57	7776-1aa x Y854	13233	47.90	13.79	0.2	159	87.1	5.0
Y931DH89	C790-68CMS x Y731/D	13210	48.64	13.59	0.3	159	85.1	3.9
Y931H89	C790-68CMS x Y731	12876	46.15	14.00	1.2	163	83.6	4.1
Y954H58	7776-20aa x Y854	12737	46.69	13.65	0.3	159	82.7	4.7
SS NB3	Spreckels	12607	47.29	13.31	0.3	156	83.6	6.1
HH46	Holly	12523	45.82	13.66	0.3	162	84.7	5.1
MEAN		13793	49.18	14.01	0.3	158	84.3	4.5
LSD (.05)		1807	5.60	0.68	0.7NS	NS	0.0	0.5
C.V. (%)		9.2	8.00	3.40	226.1	4.9	2.2	15.1
F value		2.1	1.66	3.13	3.3NS	1.5NS	1.1	9.4**

[1]BYV inoculated and % loss are summarized on the following page.
[2]Means over both virus treatments.
[3]PM rating 8/23/90 and 9/5/90.
[4]HO = CMS; aa = genetic ms.

TEST 1590. BYV INOCULATED EVALUATION OF HYBRIDS WITH SYNTHETICS OF C31 & C54, SALINAS, CA., 1990

Split-block with 4 replications
16 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: February 28, 1990
Harvested: October 16, 1990
BYV Inoculated: May 15, 1990

Variety	Description	Sugar Yield Inoc. Lbs/A	Sugar Yield Loss %	Beets Yield Inoc. Tons	Beets Yield Loss %	Sucrose Inoc. %	Sucrose Loss %	RJAP %	Mean Yellows[5] Rating
Y931SH77	7776HO x Y931/S	11933	14.0	42.46	15.1	14.04	-1.4	83.5	2.7
Y731H89	C790-68CMS x F86-31/6	11732	17.0	42.07	15.9	13.91	1.2	85.4	2.3
Y731H77	5776HO x F86-31/6	11647	20.8	43.06	18.6	13.52	3.0	82.1	2.7
Y931H89	C790-68CMS x Y731	11523	9.8	41.38	9.2	13.91	0.4	82.9	2.8
Y931SH89	C790-68CMS x Y731/S	11442	18.9	39.90	19.3	14.38	-0.7	84.2	3.0
Y931DH77	7776HO x Y731/D	11162	28.1	41.08	25.5	13.55	3.7	82.6	2.4
Y931DH89	C790-68CMS x Y731/D	11060	16.3	39.38	18.8	14.05	-3.4	84.6	2.2
Y931H77	7776HO x Y731	10679	17.8	40.04	15.4	13.32	3.7	83.4	2.8
Y954H76	8776aa x Y854	10487	27.6	37.49	21.9	13.94	7.5	82.5	3.2
Y954H57	7776-1aa x Y854	10026	23.7	35.20	26.3	14.25	-3.5	84.2	3.0
HH46	Holly	9804	21.7	35.27	23.1	13.90	-1.8	82.9	3.2
Y954H58	7776-20aa x Y854	9711	23.8	35.61	23.7	13.55	0.7	82.8	3.2
4757	Betaseed	9541	37.1	34.13	34.4	13.99	4.1	81.5	3.4
Y954H59	7776-21aa x Y854	9465	33.1	34.39	30.2	13.66	4.7	81.4	3.4
Y954H60	7776-25aa x Y854	9166	32.7	33.52	30.5	13.66	3.0	84.4	3.5
SS NB3	Spreckels	7620	39.2	29.69	37.0	12.80	3.8	83.1	4.4
MEAN		10437	23.8	37.79	22.8	13.78	1.5	83.2	3.0
LSD (.05)		1362	14.4	3.92	12.3	0.00	6.7	2.4	0.7
C.V. (%)		9.2	42.4	7.30	37.9	4.60	4.6	2.10	15.80
F value for varieties		4.7**	2.8	4.8**	3.1	2.2**	1.8	1.7**	5.5**
F value for virus treatments		266.5**	--	174.3**	--	1.2**	--	10.6**	--
F value for variety x virus		2.4**	--	2.5**	--	1.8*	--	1.0*	--

[5]Mean virus yellows scores from 6/20, 6/27 and 7/6/90. Scored from 0 = no symptoms to 9 = 100% of matured leaf canopy yellowed.

TEST 1690. NON-INOCULATED EVALUATION OF H20 HYBRIDS WITH C31 SYNTHETICS & LINES, SALINAS, CA., 1990

Split-block with 4 replications
16 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: February 28, 1990
Harvested: October 15, 1990
Not Inoculated[1]

Variety	Description[4]	Acre Yield Sugar lbs	Acre Yield Beets Tons	Sucrose %	Root Rot[2] %	Beets/ 100'[2] No.	RJAP %	Powdery Mildew[2,3] Rating
Y931-43H20	87-309H3 x Y731-43	14112	47.89	14.70	0.0	152	84.8	5.4
Y931-89H20	87-309H3 x Y731-89	13891	48.43	14.35	0.8	157	83.4	6.3
4757	Betaseed	13801	48.23	14.30	0.2	154	84.6	4.3
Y931H20	87-309H3 x Y731	13197	48.50	13.60	0.3	154	83.7	5.2
Y931-94H20	87-309H3 x Y731-94	12985	46.15	14.05	0.0	156	82.5	5.6
Y931DH20	87-309H3 x Y731/D	12948	47.38	13.61	0.3	156	81.9	5.3
Y731H20	86-309H3 x F86-31/6	12883	46.92	13.68	0.3	162	81.9	5.1
Y931-10H20	87-309H3 x Y731-10	12857	46.05	13.98	0.0	151	83.7	4.8
Y931-75H20	87-309H3 x Y731-75	12601	45.68	13.74	0.2	161	83.4	5.8
Y954H20	87-309H3 x Y854 (C54)	12555	43.93	14.23	0.3	156	84.4	5.8
9102H8	F82-546H3 x 8102 (C12T)	12546	45.14	13.90	0.0	151	84.4	4.9
Y931SH20	87-309H3 x Y731/S	12396	45.33	13.64	0.5	150	83.6	5.3
Y931-71H20	87-309H3 x Y731-71	11793	42.59	13.85	0.0	145	83.0	5.0
HH46	Holly	11631	41.00	14.18	0.0	159	85.3	5.3
SSNB3	Spreckels	11050	42.74	12.90	0.9	150	85.1	6.1
US H11	C546H3 x C36 (L786442)	10578	42.12	12.55	0.3	152	83.5	6.8
MEAN		12614	45.51	13.83	0.3	154	83.7	5.4
LSD (.05)		1593	4.26	0.78	NS	NS	0.0	0.7
C.V. (%)		8.9	6.60	3.9	325.0	6.5	2.0	10.3
F value		3.1	2.61	3.8	0.8NS	1.6NS	1.5	5.9**

[1]BYV inoculated and % loss are summarized on the following page.
[2]Means over both virus treatments.
[3]PM rating 8/23/90 and 9/5/90.
[4]HO = CMS; aa = genetic ms.

TEST 1690. BYV INOCULATED EVALUATION OF H20 HYBRIDS WITH C31 SYNTHETICS & LINES, 1990

Split-block with 4 replications
16 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: February 28, 1990
Harvested: October 15, 1990
BYV Inoculated: May 15, 1990

Variety	Description	Sugar Yield Inoc.	Sugar Yield Loss	Beets Yield Inoc.	Beets Yield Loss	Sucrose Inoc.	Sucrose Loss	RJAP	Mean Yellows[5]
		Lbs/A	%	Tons	%	%	%	%	Rating
Y931-89H20	87-309H3 x Y731-89	10692	22.6	37.55	22.1	14.24	0.7	83.0	2.7
Y731H20	86-309H3 x F86-31/6	10446	17.9	37.01	20.8	14.10	-3.4	85.7	2.7
Y931H20	87-309H3 x Y731	10332	21.4	37.49	22.5	13.80	-1.5	84.2	2.9
Y931-43H20	87-309H3 x Y731-43	10298	26.8	37.68	20.9	13.64	7.3	82.7	3.2
Y931-10H20	87-309H3 x Y731-10	10123	20.7	35.54	22.2	14.24	-2.0	83.8	3.2
Y931-94H20	87-309H3 x Y731-94	9718	25.4	35.86	22.3	13.50	3.8	82.8	3.3
Y931DH20	87-309H3 x Y731/D	9653	24.2	35.54	24.5	13.57	0.0	82.7	2.8
Y931-71H20	87-309H3 x Y731-71	9567	18.8	35.27	17.2	13.59	2.0	81.9	2.5
Y931-75H20	87-309H3 x Y731-75	9504	23.6	34.53	23.5	13.74	0.0	84.2	2.8
Y931SH20	87-309H3 x Y731/S	9308	24.9	33.85	25.4	13.68	-0.4	83.1	2.9
Y954H20	87-309H3 x Y854 (C54)	8783	30.3	32.25	26.8	13.51	5.0	83.7	3.5
HH46	Holly	8171	29.9	29.63	27.7	13.75	3.0	83.1	3.4
4757	Betaseed	8156	40.6	30.29	36.9	13.43	6.2	81.3	3.7
9102H8	F82-546H3 x 8102 (C12T)	7772	37.9	27.94	38.2	13.75	0.9	83.1	4.5
SSNB3	Spreckels	7712	29.8	29.59	30.6	13.04	-1.1	84.6	4.3
US H11	C546H3 x C36 (L786442)	6926	33.8	30.77	26.6	11.25	10.3	81.3	2.9
MEAN		9197	26.8	33.80	25.5	13.55	1.9	83.2	3.2
LSD (.05)		1117	13.5	3.43	10.7	0.81	7.6	2.2	0.7
C.V. (%)		9.0	35.3	7.10	29.5	4.20	227.7	1.9	15.7
F value for varieties		7.7**	1.9**	7.5**	2.3**	7.2**	2.0*	1.3**	5.2**
F value for virus treatments		146.6**	--	162.3**	--	3.5**	--	5.1**	--
F value for variety x virus		1.5**	--	1.7**	--	1.9*	--	2.6*	--

[5]Mean virus yellows scores from 6/20, 6/27 and 7/6/90. Scored from 0 = no symptoms to 9 = 100% of matured leaf canopy yellowed.

TEST 1790. NONINOCULATED EVALUATION OF SUGARBEET GERMPLASM, SALINAS, CA., 1990

Split-block with 4 replications
32 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: February 28, 1990
Harvested: October 10-11, 1990
Not Inoculated[1]

Variety	Description[4]	Acre Yield		Sucrose	Root Rot[2]	Beets/ 100'[2]	RJAP	Powdery Mildew[2,3]
		Sugar Lbs	Beets Tons	%	%	No.	%	Rating
R980	RZM 8244	15146	50.38	15.02	0.0	149	82.5	4.3
9912	RZM 8908-8911aa x A	14741	52.09	14.16	0.3	144	81.9	4.6
R939C5 (C39R	RZM R839C4	14506	48.97	14.80	0.0	137	83.9	2.9
9910H47	5747aa x 8910	14292	51.73	13.82	0.3	154	82.1	5.4
R971	RZM R871	13773	48.28	14.30	0.0	124	82.2	4.4
R939/4H44	8904aa x R839C4	13719	47.02	14.56	0.0	145	83.9	2.7
9887H86	8787aa x RZM 8850-63	13547	47.36	14.30	0.3	164	82.9	6.2
Y947 (C47)	YR-ER-PMR Y747	13545	46.34	14.65	0.0	141	83.9	3.2
9911H49	7903aa x 8911	13518	47.22	14.31	0.0	146	82.7	3.6
R978C1	Inc. R878	13418	46.44	14.41	0.6	137	82.9	2.6
R947C5 (C47R	RZM R847C4	13410	47.58	14.13	0.3	153	83.1	4.3
Y931-43	Inc. Y731-43	13378	45.34	14.75	0.3	134	83.7	3.7
9102 (C12T)	Inc. 9102	13212	43.33	15.25	0.0	142	85.2	3.6
9867H67	8767aa x 8852,7	13106	45.51	14.40	0.0	157	83.0	4.9
R970	RZM R871-R879	13074	47.67	13.71	0.0	132	80.8	3.9
Y949 (C49)	Inc. Y849	13010	42.64	15.26	0.3	142	83.1	2.8
R977	RZM R877	12783	44.27	14.45	0.3	140	81.4	3.8
9866H80	8755aa x 8853,5,6	12749	42.20	15.11	0.0	165	82.5	4.9
9876H76	8776aa x 8860,1,2,3	12702	44.87	14.15	0.0	158	81.4	5.4
Y956	YR-ER-PMR Y756, Y656	12524	42.72	14.65	0.0	155	83.4	3.7

TEST 1790. NONINOCULATED EVALUATION OF SUGARBEET GERMPLASM, SALINAS, CA., 1990
(continued)

Variety	Description[4]	Acre Yield Sugar lbs	Acre Yield Beets tons	Sucrose %	Root Rot[2] %	Beets/ 100'[2] No.	RJAP %	Powdery Mildew[2,3] Rating
Y954 (C54)	Inc. Y854	12509	42.63	14.68	0.0	133	83.6	3.3
9903	YR-ER-PMR 7903 (A,aa)	12412	45.01	13.79	0.0	150	83.7	4.0
Y939 (C39)	YR-ER-PMR Y739	12391	41.32	14.99	0.0	152	83.4	2.3
Y941	YR-ER-PMR Y741 (C91)	12305	43.53	14.20	0.3	148	83.0	2.8
Y948 (C93)	YR-ER-PMR Y748	11931	38.96	15.31	0.0	142	83.2	3.3
9101 (C11T)	Inc. 8101	11590	39.74	14.59	0.0	131	83.9	2.5
R979	Inc. R879	11412	41.02	13.93	0.0	143	82.4	4.7
9905	YR-ER-PMR 7905 (A,aa)	11130	41.78	13.30	0.0	135	81.9	4.2
Y846 (C46/3)	YR-ER-PMR Y646	11047	37.50	14.71	0.0	157	82.7	3.3
U86-37	Inc. C37 (86443)	10349	37.82	13.69	0.0	158	81.5	5.7
768	Inc. 868 (US 75)	9899	40.70	12.11	0.0	149	79.4	5.7
SP7622-0	L80466 (8/87)	8753	33.72	12.98	0.2	159	84.3	5.1
MEAN		12684	44.24	14.33	0.1	146	82.8	4.0
LSD (.05)		1443	4.78	0.80	NS	13	2.3	0.9
C.V. (%)		8.1	7.70	4.00	465.5	8.6	2.00	19.2
F value		7.4	6.16	5.90	1.0NS	5.3NS	1.92	11.5**

[1]BYV inoculated and % loss are summarized on the following page.
[2]Means over both virus treatments.
[3]PM rating 8/24/90 and 9/6/90.
[4]HO = CMS; aa = genetic ms.

TEST 1790. BYV INOCULATED EVALUATION OF SUGARBEET GERMPLASM, SALINAS, CA., 1990

Split-block with 4 replications
32 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: February 28, 1990
Harvested: October 10-11, 1990
BYV Inoculated: May 15, 1990

Variety	Description	Sugar Yield		Beets Yield		Sucrose		RJAP	Mean Yellows[5]
		Inoc.	Loss	Inoc.	Loss	Inoc.	Loss		
		Lbs/A	%	Tons	%	%	%	%	Rating
Y947 (C47)	YR-ER-PMR Y747	11123	30.3	37.88	25.4	14.71	7.4	83.5	2.4
Y939 (C39)	YR-ER-PMR Y739	10767	31.4	35.20	28.9	15.29	3.5	84.2	2.6
9910H47	5747aa x 8910	10418	34.6	39.41	32.4	13.23	3.4	80.9	2.8
Y931-43	Inc. Y731-43	10262	34.0	35.38	29.0	14.44	7.0	82.2	2.8
R939/4H44	8904aa x R839C4	10155	25.5	36.67	21.8	13.84	4.9	81.3	2.7
9903	YR-ER-PMR 7903 (A,aa)	9994	24.5	35.49	22.3	14.09	3.0	83.6	2.5
R980	RZM 8244	9928	33.7	34.73	30.6	14.32	4.4	80.1	2.9
R939C5 (C39R)	RZM R839C4	9924	27.1	36.04	23.8	13.71	4.2	81.1	2.4
Y949 (C49)	Inc. Y849	9886	32.3	34.78	27.1	14.21	7.9	81.8	2.8
R970	RZM R871-R879	9829	33.2	36.91	31.2	13.30	3.1	79.5	3.0
R977	RZM R877	9687	41.2	32.38	38.7	14.96	3.8	81.7	3.2
9912	RZM 8908-8911aa x A	9578	30.8	35.13	27.1	13.64	5.0	81.0	3.3
R971	RZM R871	9503	17.2	35.15	17.1	13.52	-0.6	81.2	3.2
Y956	YR-ER-PMR Y756, Y656	9341	29.0	33.18	22.4	14.06	8.1	81.2	3.1
9911H49	7903aa x 8911	9152	21.0	33.12	20.2	13.80	2.0	81.4	2.9
Y941	YR-ER-PMR Y741 (C91)	9095	26.8	32.56	25.3	13.99	1.9	81.2	2.5
Y954 (C54)	Inc. Y854	9072	25.2	31.64	22.2	14.34	3.8	81.5	3.2
9866H80	8755aa x 8853,5,6	9014	34.2	32.51	31.4	13.89	3.6	81.7	4.2
R947C5 (C47R)	RZM R847C4	8990	23.3	34.37	17.7	13.01	6.8	81.8	2.7
9887H86	8787aa x RZM 8850-63	8921	40.8	33.59	34.4	13.29	9.4	82.0	3.4

TEST 1790. BYV INOCULATED EVALUATION OF SUGARBEET GERMPLASM, SALINAS, CA., 1990
(continued)

Variety	Description	Sugar Yield Inoc.	Sugar Yield Loss	Beets Yield Inoc.	Beets Yield Loss	Sucrose Inoc.	Sucrose Loss	RJAP	Mean Yellows[5]
		Lbs/A	%	Tons	%	%	%	%	Rating
R978C1	Inc. R878	8895	24.2	31.96	26.8	13.93	-3.6	82.2	3.7
Y948 (C93)	YR-ER-PMR Y748	8887	25.4	30.78	20.7	14.40	5.9	81.4	2.5
Y846 (C46/3)	YR-ER-PMR Y646	8553	35.0	29.88	33.7	14.31	2.0	82.1	2.9
9876H76	8776aa x 8860,1,2,3	8314	19.4	30.70	21.2	13.64	-2.2	81.7	3.5
9905	YR-ER-PMR 7905 (A,aa)	8249	33.5	31.22	30.4	13.25	3.8	79.5	2.8
U86-37	Inc. C37 (86443)	8241	20.5	29.83	21.2	13.85	-1.3	81.5	2.3
9102 (C12T)	Inc. 9102	7780	12.9	26.56	14.7	14.65	-2.1	83.1	4.0
9867H67	8767aa x 8852,7	7750	24.4	29.82	23.2	13.04	1.3	81.2	4.1
R979	Inc. R879	7569	21.8	28.33	20.1	13.39	2.4	79.5	2.8
9101 (C11T)	Inc. 8101	7546	25.1	26.41	24.3	14.29	0.2	82.9	4.4
768	Inc. 868 (US 75)	6255	35.6	28.60	29.2	10.94	9.5	78.7	3.7
SP7622-0	L80466 (8/87)	4381	48.5	20.48	38.7	10.63	17.4	78.8	4.9
MEAN		8970	28.8	32.52	26.0	13.75	3.9	81.4	3.1
LSD (.05)		1184	13.9	3.90	13.4	0.92	0.6	2.9	0.6
C.V. (%)		9.4	34.4	8.50	36.7	4.80	1.4	2.6	13.7
F value for varieties		18.2**	2.3**	15.4**	1.6**	14.1**	1.7**	2.8**	9.1**
F value for virus treatments		94.7**	--	125.8**	--	14.9**	--	53.8**	--
F value for variety x virus		1.8**	--	1.3**	--	1.6*	--	0.8*	--

[5]Mean virus yellows scores from 6/20, 6/27 and 7/6/90. Scored from 0 = no symptoms to 9 = 100% of matured leaf canopy yellowed.

TEST 2190. BYV NONINOCULATED EVALUATION OF C31 SYNTHETIC + LINES, SALINAS, CA., 1990

Split-block with 8 replications
16 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: February 28, 1990
Harvested: October 1-2, 1990
Not Inoculated[1]

Variety	Description[4]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Root Rot[2] %	Beets/ 100'[2] No.	RJAP %	Powdery Mildew[2,3] Rating
R980	RZM 8244 (C54Rz)	15256	50.80	15.02	0.2	132	83.5	4.1
9102	Inc. 8102 (C12T)	14800	46.78	15.79	0.0	121	86.8	3.7
Y931-43	Inc. Y731-43	14632	47.77	15.34	0.3	129	84.6	4.2
Y931-89	Inc. Y731-89	14431	48.83	14.76	0.0	130	83.2	3.8
F86-31/6	Inc. C31/6 (86263)	14423	48.78	14.82	1.0	132	83.4	3.6
Y931S	Inc. Y731-HS (Salinas)	14196	48.03	14.77	0.5	129	83.7	3.6
R971	RZM R871 (C31Rz)	14151	50.05	14.16	0.7	118	82.8	5.0
Y931-94	Inc. Y731-94	13863	46.16	15.00	0.5	124	84.4	3.3
Y954	Inc. Y854 (C54)	13394	45.58	14.66	0.0	131	84.7	3.8
Y931	Inc. Y731 (Mass)	13323	46.59	14.28	0.6	131	82.8	2.9
Y931D	Inc. Y731-HS (Davis)	13052	46.79	13.93	0.4	126	83.2	3.1
Y931-71	Inc. Y731-71	12676	44.75	14.15	0.0	121	83.5	3.0
Y931-75	Inc. Y731-75	12288	43.45	14.18	1.0	122	82.4	3.2
Y931-10	Inc. Y731-10	11784	41.65	14.16	1.1	116	83.9	2.6
768	Inc. 868 (US 75)	10943	43.51	12.54	0.5	131	81.1	6.5
SP7622-0	Inc. SP22-0 (L80466)	10634	39.00	13.63	0.3	128	84.8	5.3
MEAN		13365	46.16	14.45	0.4	126	83.7	3.9
LSD (.05)		1370	4.03	0.71	0.8	12	2.0	0.6
C.V. (%)		10.3	8.8	4.9	242.9	8.1	2.4	15.7
F value		8.0	4.7	8.9	1.7	1.6	3.2	19.8

[1]BYV inoculated and % loss are summarized on the following page.
[2]Means over both virus treatments.
[3]PM rating 8/24/90 and 9/7/90.
[4]HO = CMS; aa = genetic ms.

TEST 2190. BYV INOCULATED EVALUATION OF C31 SYNTHETICS + LINES, SALINAS, CA., 1990

Split-block with 8 replications
16 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: February 28, 1990
Harvested: October 1-2, 1990
BYV Inoculated: May 15, 1990

Variety	Description	Sugar Yield Inoc. Lbs/A	Sugar Yield Loss %	Beets Yield Inoc. Tons	Beets Yield Loss %	Sucrose Inoc. %	Sucrose Loss %	RJAP %	Mean Yellows[5] Rating
Y931-89	Inc. Y731-89	12075	16.1	41.74	14.3	14.45	2.0	83.6	2.4
Y931D	Inc. Y731-HS (Davis)	11794	8.8	41.84	10.3	14.07	-1.3	84.3	2.3
Y931S	Inc. Y731-HS (Salinas)	11531	18.3	39.64	17.3	14.53	1.4	82.5	2.5
Y931-43	Inc. Y731-43	11472	21.1	38.92	18.2	14.74	3.7	84.0	2.8
R971	RZM R871 (C31Rz)	10978	22.2	39.95	20.0	13.77	2.6	83.3	3.2
Y931-94	Inc. Y731-94	10905	20.6	37.36	18.6	14.59	2.6	83.3	2.8
F86-31/6	Inc. C31/6 (86263)	10854	24.6	38.61	20.6	14.07	4.9	82.1	2.5
Y931	Inc. Y731 (Mass)	10606	20.1	38.65	17.0	13.73	3.7	83.5	2.6
R980	RZM 8244 (C54Rz)	10405	31.5	36.07	28.7	14.44	3.8	82.4	3.3
Y931-71	Inc. Y731-71	10133	19.9	36.78	17.7	13.76	2.6	83.7	2.5
Y931-10	Inc. Y731-10	10039	14.9	35.83	13.8	14.01	1.0	83.6	2.8
Y931-75	Inc. Y731-75	9817	19.7	36.99	14.2	13.29	6.1	80.7	2.5
Y954	Inc. Y854 (C54)	9324	29.8	33.54	25.8	13.88	5.3	82.5	3.4
9102	Inc. 8102 (C12T)	7998	45.0	26.62	42.4	15.01	4.6	84.9	4.6
768	Inc. 868 (US 75)	6622	38.1	29.16	32.2	11.38	9.0	79.5	4.0
SP7622-0	Inc. SP22-0 (L80466)	5065	52.5	22.17	43.2	11.40	16.3	78.7	5.2
MEAN		9976	25.2	35.87	22.1	13.82	4.3	82.7	3.1
LSD (.05)		958	7.3	2.93	6.1	0.71	5.9	1.9	0.3
C.V. (%)		9.7	29.3	8.20	27.7	5.10	139.4	2.4	11.4
F value for varities		17.3**	19.6**	12.7**	20.4**	19.2**	3.5*	6.9**	45.6**
F value for virus treatments		219.0**	--	254.6**	--	63.0**	--	17.3**	--
F value for variety x virus		11.2**	--	12.5**	--	3.0*	--	2.7*	--

[5]Mean virus yellows scores from 6/20, 6/27 and 7/7/90. Scored from 0 = no symptoms to 9 = 100% of matured leaf canopy yellowed.

TEST 1890. NON-INOCULATED EVALUATION OF SB x BM GERMPLASM, SALINAS, CA., 1990

Split-block with 4 replications
8 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: February 28, 1990
Harvested: October 2, 1990
Not Inoculated[1]

Variety	Description[4]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Root Rot[2] %	Beets/ 100'[2] No.	RJAP %	Powdery Mildew[2,3] Rating
R922 Y	BYVR R722	13204	47.79	13.84	0.3	150	82.6	4.2
Y954 (C54)	Inc. Y854	12822	44.69	14.36	0.0	138	84.2	3.4
R922 S	BYVR R722%S	12786	45.62	14.01	0.0	142	84.0	5.1
R922 R	RZM R722	12728	45.58	13.95	0.0	149	83.0	4.9
U86-37	Inc. C37 (86443)	10857	39.66	13.66	0.0	156	81.7	5.6
R924 (C48)	RZM R824 (C37 x W841)	10844	38.58	14.06	0.0	141	81.1	4.8
R722 (C50)	Inc. F2(Y54 x B.m.)	10643	39.76	13.35	0.3	137	81.0	3.9
R925 (C48)	RZM R825 (C37 x WB42)	9966	37.02	13.45	0.0	129	79.5	5.1
MEAN		11731	42.34	13.84	0.1	143	82.1	4.6
LSD (.05)		1368	4.07	0.00	NS	12	2.9	0.7
C.V. (%)		7.9	6.5	4.4	524.4	10.9	2.4	14.7
F value		7.5	8.4	1.2	1.0NS	4.4NS	2.6	9.4**

[1]BYV inoculated and % loss are summarized on the following page.
[2]Means over both virus treatments.
[3]PM rating 8/24/90 and 9/7/90.
[4]HO = CMS; aa = genetic ms.

TEST 1890. BYV INOCULATED EVALUATION OF SB x BM GERMPLASM, SALINAS, CA., 1990

Split-block with 4 replications
8 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: February 28, 1990
Harvested: October 2, 1990
BYV Inoculated: May 15, 1990

Variety	Description	Sugar Yield Inoc.	Sugar Yield Loss	Beets Yield Inoc.	Beets Yield Loss	Sucrose Inoc.	Sucrose Loss	RJAP	Mean Yellows[5]
		Lbs/A	%	Tons	%	%	%	%	Rating
Y954 (C54)	Inc. Y854	9662	24.6	24.99	21.8	13.76	3.8	83.0	3.2
R922 Y	BYVR R722	9199	30.3	33.71	29.5	13.66	0.9	81.4	3.1
R922 R	RZM R722	9034	28.4	35.94	21.1	12.57	9.6	80.5	2.9
R922 S	BYVR R722%S	8916	29.9	33.33	26.5	13.38	4.5	82.4	3.3
U86-37	Inc. C37 (86443)	8596	19.7	30.63	22.4	13.94	-2.3	82.1	2.6
R924 (C48)	RZM R824 (C37 x W841)	8554	20.9	32.13	16.6	13.29	5.4	78.4	2.5
R722 (C50)	Inc. F2 (Y54 x B.m.)	7986	24.6	33.68	15.3	11.98	10.3	80.3	2.8
R925 (C48)	RZM R825 (C37 x WB42)	7692	22.6	29.96	18.6	12.77	5.0	78.3	2.3
MEAN		8705	25.1	33.05	21.5	13.17	4.6	80.8	2.8
LSD (.05)		0	0.0	0.0	0.0	1.2	0.0	3.1	0.6
C.V. (%)		11.6	47.7	9.8	44.1	6.2	7.4	2.6	14.1
F value for varieties		9.4**	0.5**	7.1**	1.0**	4.4**	1.0*	4.2**	2.8**
F value for virus treatments		128.1**	--	110.2**	--	94.5**	--	17.0**	--
F value for variety x virus		1.0**	--	1.8**	--	0.9*	--	0.6**	--

[5]Mean virus yellows scores from 6/20, 6/27 and 7/6/90. Scored from 0 = no symptoms to 9 = 100% of matured leaf canopy yellowed.

TEST 2090. BYV NONINOCULATED EVALUATION OF SBxBM GERMPLASM, SALINAS, CA., 1990

Split-block with 8 replications
8 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: February 28, 1990
Harvested: October 4, 1990
Not Inoculated[1]

Variety	Description[4]	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Root Rot[2] %	Beets/ 100'[2] No.	RJAP %	Powdery Mildew[2,3] Rating
R922 S	BYVR R722%S	12543	44.77	13.97	0.3	147	83.3	4.4
R922 Y	BYVR R722	12010	42.13	14.26	0.3	154	83.8	4.2
Y954	Inc. Y854 (C54)	11654	39.76	14.66	0.0	145	83.8	3.2
R922 R	RZM R722	11408	40.87	13.96	0.1	158	81.4	5.0
R722	Inc. F2 (Y54 x B.m.)	10601	37.16	14.27	0.3	145	82.3	4.5
U86-37	Inc. C37 (86443)	10379	36.03	14.40	0.2	156	82.7	5.3
R921	RZM R821 (C37 x WB-41,42)	10003	34.86	14.35	0.1	154	79.9	5.0
768	Inc. 868 (US 75)	9447	38.37	12.34	0.0	148	80.8	5.7
MEAN		11006	39.24	14.03	0.2	151	82.2	4.7
LSD (.05)		888	2.72	0.52	NS	8	1.9	0.6
C.V. (%)		8.00	6.9	3.7	367.3	6.5	2.3	14.7
F value		11.72	12.0	15.5	0.7	3.5	4.8	12.6

[1]BYV inoculated and % loss are summarized on the following page.
[2]Means over both virus treatments.
[3]PM rating 8/24/90 and 9/7/90.
[4]HO = CMS; aa = genetic ms.

TEST 2090. BYV INOCULATED EVALUATION OF SBxBM Germplasm, SALINAS, CA., 1990

Split-block with 8 replications
8 entries x 2 virus treatments
1-row plots, 30 ft. long

Planted: February 28, 1990
Harvested: October 4, 1990
BYV Inoculated: May 15, 1990

Variety	Description	Sugar Yield Inoc. Lbs/A	Sugar Yield Loss %	Beets Yield Inoc. Tons	Beets Yield Loss %	Sucrose Inoc. %	Sucrose Loss %	RJAP %	Mean Yellows[5] Rating
R922 Y	BYVR R722	9468	20.9	35.01	16.6	13.51	5.2	81.0	2.9
R922 R	RZM R722	8925	22.0	34.65	15.4	12.84	3.5	80.0	2.8
R922 S	BYVR R722%S	8904	27.9	33.12	25.4	13.45	6.6	82.3	3.3
Y954	Inc. Y854 (C54)	8736	24.5	31.93	19.2	13.67	7.9	84.1	3.2
R722	Inc. F2 (Y54 x B.m.)	8079	23.7	31.32	15.8	12.92	9.5	80.3	2.7
U86-37	Inc. C37 (86443)	7859	24.0	29.26	18.6	13.43	6.6	81.9	2.4
R921	RZM R821 (C37 x WB-41,42)	7028	29.7	27.90	19.9	12.56	12.5	78.6	2.6
768	Inc. 868 (US 75)	6334	32.4	27.71	27.2	11.44	6.7	81.3	4.0
MEAN		8167	25.7	31.36	19.8	12.98	7.3	81.2	3.0
LSD (.05)		869	0.0	2.90	7.2	0.56	5.3	1.7	0.4
C.V. (%)		10.5	34.5	9.10	36.2	4.30	72.2	2.10	12.7
F value for varieties		19.6**	1.6**	12.8**	3.0**	23.3**	2.1*	8.9**	15.0**
F value for virus treatments		214.0**	--	88.7**	--	53.4**	--	9.6**	--
F value for variety x virus		1.1**	--	3.6**	--	2.2*	--	1.9*	--

[5]Mean virus yellows scores from 6/20, 6/27 and 7/7/90. Scored from 0 = no symptoms to 9 = 100% of matured leaf canopy yellowed.

VARIETY TRIALS, BRAWLEY, CALIFORNIA, 1989-90

USDA-ARS, Irrigated Desert Research Station

Tests were located in 90 beds on the south side of block K. Rotation included sugarbeet in 1986-87 and cereals in 1987-89. All fertilizer was applied as 46:0:0 and 11:52:0 for a total of 150 units of N and 160 units of P_2O_5.

Summary: Arrangement of 1989-90 Tests

Test No.	Entries per Test	No. Reps	Rows per Plot[1]	Plot Length (ft)	Harv. Date	Test Design	No. Sugar Samples/ Plot
190[2]	2	6	4	6	[2]	Split-plot	2
B290	20	10	1	40	May 17-18	RCB	2
B390[3]	23	10	1	40	May 21-22	RCB	2
B490[4]	72	4	1	10.5	May 22-23	RCB[5]	1
B590	32	8	1	24	May 23-24	RCB	1
B690	16	4	1	24	May 23	RCB	2
B790	32	4	1	24	May 18	RCB	2

[1] Rows 30" wide.
[2] Date of planting x Date of harvest x Variety test at a 2nd location (4 planting dates x 3 harv. dates).
[3] Area 5 Coded Variety Trial.
[4] 72 x 4 Half-sib Progeny Test.
[5] Incomplete block with 9 entries per set.

Remarks: The tests were uniform with high and uniform stands. Empoasca and mites were present but not severe. Powdery mildew was light to moderate, depending upon the variety. BWYV infection was probably 100%, but occurred mid-to-late in the growing cycle. LIYV was light to moderate (probably about 30% of plants infected) and less important than in most previous years. Bolting was light. BNYVV was determined by soil tests and tissue (ELISA) analyses and appeared to be confined to the first 8-10 rows of test B290. Symptoms were very mild compared to spring planted beets in the SJV. Only occasional plants showed fairly typical rhizomania symptoms. Even though Erwinia was present in commercial fields in IV in 1990, essentially nothing detected in these trials.

Phoma(?) in hybrids with 755 parental lines. C309, C312. C312 quite severe.

TEST B290. PERFORMANCE OF ADVANCED GERMPLASM, BRAWLEY, CA., 1989-90

20 entries x 10 reps, RCB
1-row plots, 40 ft. long

Planted: September 19, 1989
Harvested: May 17-18, 1990

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Beets/ 100' No.	Clean Beets %	Nitrate Nitrogen Rating
Y931H40	C313CMS x Y731	9,167	31.50	14.59	2.4	123	96.2	2.7
9911H118	8855aa x 8911	8,770	29.02	15.10	8.5	133	94.9	3.0
R847H23	87-309H37 x R747	8,639	28.82	14.99	4.2	134	94.1	2.5
HH51	51320 Holly	8,499	30.11	14.10	0.5	136	95.3	3.0
Y931H37	85-306CMS x Y731	8,373	30.36	13.73	1.5	121	95.2	2.8
Y931H39	C762-17CMS x Y731	8,369	30.42	13.75	0.8	127	94.5	2.6
Y846H38	C312CMS x Y746	8,319	28.69	14.46	0.0	126	94.6	2.7
Y931/SH20	87-309H3 x Y731/S	8,272	28.04	14.78	0.8	130	95.3	2.4
Y954H19	88-790-68H37 x Y854	8,171	27.97	14.52	4.1	132	94.2	2.6
HH41	41138 Holly	8,103	28.38	14.29	0.8	137	94.9	2.7
Y931H26	87-309CMS x Y731	8,053	27.58	14.60	1.1	125	94.9	2.5
Y931H19	88-790-68H37 x Y731	8,040	28.40	14.15	7.0	129	94.5	3.0
Y931/DH20	87-309H3 x Y731/D	7,919	27.30	14.45	1.6	136	95.6	2.4
Y931/SH89	88-790-68CMS x Y731/S	7,746	25.85	14.98	5.5	119	93.9	2.4
Y931H89	88-790-68CMS x Y731	7,671	26.29	14.59	8.1	122	94.1	2.5
Y931H20	87-309H3 x Y731	7,630	26.78	14.25	0.9	126	94.2	2.2
Y931/DH89	88-790-68CMS x Y731/D	7,549	25.65	14.70	6.3	121	94.8	2.6
Y954H38	C312CMS x Y854	7,511	27.12	13.84	0.1	129	93.5	2.5
Y931H38	C312CMS x Y731	7,297	26.05	13.93	0.6	128	95.1	2.3
US H11	786442 Union	7,258	25.93	13.99	0.7	137	92.3	2.9
MEAN		8,068	28.01	14.39	2.8	128	94.6	2.6
LSD (.05)		713	2.2	0.5	2.6	7.3	1.2	0.5
C.V. (%)		9.8	9.0	3.6	106.2	6.4	1.4	19.6
F value		3.9**	4.5**	6.5**	9.0**	4.8**	3.4**	1.9*

TEST B590. RETEST OF HYBRID PERFORMANCE OF MULTIGERM & MONOGERM BREEDING LINES
BRAWLEY, CA., 1989-90

32 entries x 8 reps, RCB
1-row plots, 24 ft. long

Planted: September 19, 1989
Harvested: May 23-24, 1990

Variety	Description	Acre Yield		Sucrose	Bolters	Beets/ 100'	Clean Beets	Nitrate Nitrogen
		Sugar Lbs	Beets Tons	%	%	No.	%	Rating
Y954H37	85-306CMS x Y854	10,170	33.31	15.28	0.3	138	97.4	2.0
Y954H39	C762-17H x Y854	9,218	29.35	15.69	0.0	156	95.7	2.0
Y954H40	C313CMS x Y854	9,122	29.08	15.69	0.4	146	96.5	1.5
R970H20	87-309H3 x RZMR871	9,116	28.70	15.88	5.2	154	96.5	2.0
HH41	L 41138, Holly	8,967	29.22	15.33	1.3	158	95.7	2.5
Y954H118	8855aa x Y854	8,967	27.84	16.12	4.8	142	96.7	2.1
9912H20	87-309H3 x RZM8908	8,676	28.06	15.47	0.3	158	96.1	1.8
Y954H38	C312CMS x Y854	8,641	29.09	14.88	0.6	159	97.0	2.0
Y954H113	8858aa x Y854	8,565	26.26	16.32	0.0	139	96.5	1.5
Y846H20	87-309H3 x Y746	8,497	27.03	15.71	0.0	145	94.9	1.8
N902-5H20	87-309H3 x 8204,6	8,496	27.97	15.19	0.3	161	96.3	2.2
Y931H20	87-309H3 x Y731	8,320	27.04	15.40	1.4	153	95.4	2.0
Y954H20	87-309H3 x Y854	8,245	25.98	15.85	0.0	154	96.2	2.1
Y954H67	8767aa x Y854	8,183	26.52	15.44	0.0	143	95.2	2.1
Y954H117	8856aa x Y854	8,168	26.37	15.47	0.6	153	97.0	2.3
9910H20	87-309H3 x 8910	8,150	26.94	15.11	0.0	156	94.6	2.7
Y954H80	C310aa x Y854	8,025	26.28	15.30	1.0	154	95.4	2.0
9911H20	87-309H3 x 8911	8,017	25.40	15.78	0.3	156	94.3	2.0
Y954H66	C766-23HO x Y854	8,013	26.69	15.02	0.4	148	96.1	2.2
9102H8	F82-546H3 x 8102(C12T)	7,964	24.10	16.54	1.4	148	93.9	1.8

TEST B590. RETEST OF HYBRID PERFORMANCE OF MULTIGERM & MONOGERM BREEDING LINES
BRAWLEY, CA., 1989-90
(continued)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Beets/ 100' No.	Clean Beets %	Nitrate Nitrogen Rating
R939/4H20	87-309H3 x R839C4	7,962	25.65	15.54	1.9	145	95.9	2.5
Y949H20	87-309H3 x Y849	7,948	25.70	15.47	0.7	156	95.1	2.1
US H11	L 786442	7,904	27.36	14.43	0.6	147	93.4	2.0
Y954H115	8857aa x Y854	7,825	25.78	15.11	1.2	146	96.1	2.5
Y954H122	8863aa x Y854	7,730	24.28	15.96	1.1	150	95.7	1.8
Y954H70	C766-62HO x Y854	7,728	25.80	14.98	0.0	156	94.4	2.5
Y954H86	8787aa x Y854	7,720	25.07	15.36	1.9	150	95.6	1.7
Y954H51	8767-27HO x Y854	7,701	25.13	15.34	0.9	150	94.6	2.2
Y954H26	87-309CMS x Y854	7,648	24.34	15.70	0.2	152	95.7	2.3
Y954H54	C767-46HO x Y854	7,585	24.34	15.60	2.8	152	96.3	2.3
Y954H8	F87-546H3 x Y854	7,071	23.09	15.26	0.0	152	95.0	1.6
9101H8	F82-546H3 x 8101 (C11T)	6,567	21.75	15.16	0.7	145	94.5	2.2
MEAN		8,216	26.55	15.48	0.9	151	95.6	2.1
LSD (.05)		716	2.06	0.72	1.8	NS	1.4	0.6
C.V. (%)		8.9	7.9	4.70	188.0	14.5	1.6	30.5
F value		5.9**	8.9**	2.8**	3.7**	1.2NS	3.7**	1.7*

TEST B790. HYBRID SCREEN OF EARLY GENERATION BREEDING LINES RESITANT TO LIYV
BRAWLEY, CA., 1989-90

32 entries x 4 reps, RCB
1-row plots, 24 ft. long

Planted: September 19, 1989
Harvested: May 18, 1990

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Beets/ 100' No.	Clean Beets %	Nitrate Nitrogen Rating
9867H33	6237-14aa x 8852,7	9,211	28.80	15.98	10.5	146	96.8	1.8
9909-7H26	87-309CMS x 7908-7	8,974	27.97	16.03	2.3	142	95.9	1.5
9909-14H26	87-309CMS x 8909-14	8,783	27.08	16.23	0.0	145	93.7	1.2
HH41	L41138 Holly	8,718	29.14	14.94	0.0	157	96.8	2.1
9707-21H26	87-309CMS x 7907-21	8,609	26.50	16.28	17.4	143	94.8	1.6
N902-1H72	83-718HO x 8201,2	8,595	29.15	14.79	2.7	146	97.2	2.1
9867H28	6235-14aa x 8852,7	8,570	27.52	15.56	16.8	133	97.1	1.6
9867H30	7908-2aa x 8852,7	8,552	28.53	14.90	0.7	151	97.1	2.5
9867H29	6235-21aa x 8852,7	8,538	27.20	15.74	5.4	153	97.5	2.1
Y931-75H20	87-309H3 x Y731-75	8,486	27.65	15.35	4.3	136	96.2	1.7
Y931-43H20	87-309H3 x Y731-43	8,474	27.26	15.56	0.0	146	96.8	1.6
Y931-89H20	87-309H3 x Y731-89	8,426	27.23	15.47	1.0	136	96.6	1.8
9911H26	87-309CMS x 8911	8,418	27.41	15.35	2.3	148	93.7	2.3
N902-1H115	8857aa x 8201,2	8,371	28.32	14.86	4.8	138	97.7	2.7
9867H34	6237-16aa x 8852,7	8,158	26.27	15.53	0.0	163	96.0	2.1
9867H32	6237-13aa x 8852,7	8,055	25.83	15.47	13.8	166	96.8	2.3
Y931-71H20	87-309H3 x Y731-71	8,018	25.88	15.49	1.4	150	96.8	1.6
Y954H59	7776-21aa x Y854	8,006	25.96	15.48	0.7	146	95.0	2.0
9867H45	8909aa x 8852,7	7,905	25.76	15.33	0.0	160	94.8	1.8
Y931H20	87-309H3 x Y731	7,867	25.60	15.35	3.1	152	95.5	1.3

TEST B790. HYBRID SCREEN OF EARLY GENERATION BREEDING LINES RESITANT TO LIYV
BRAWLEY, CA., 1989-90
(continued)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Beets/ 100' No.	Clean Beets %	Nitrate Nitrogen Rating
Y954H58	7776-20aa x Y854	7,813	27.41	14.26	1.4	151	95.9	1.7
Y931-10H20	87-309H3 x Y731-10	7,790	25.08	15.53	0.7	144	97.1	2.0
9909-13H26	87-309CMS x 8909-13	7,766	24.86	15.62	0.8	136	91.0	2.3
9908-2H26	87-309CMS x 8908-2	7,718	24.38	15.86	0.0	150	93.3	1.6
9707-14H26	87-309CMS x 7907-14	7,696	25.25	15.21	9.0	146	93.7	1.8
Y931-94H20	87-309H3 x Y731-94	7,501	24.43	15.39	0.0	146	96.1	2.1
9909-16H26	87-309CMS x 8909-16	7,491	22.84	16.40	8.1	128	92.9	1.6
Y954H57	7776-1aa x Y854	7,425	24.50	15.16	0.0	145	94.0	1.6
9867H31	6236-7aa x 8852,7	7,249	24.04	15.08	4.1	143	96.3	1.8
Y954H76	8776aa x Y854	7,216	24.22	14.90	1.4	171	94.9	2.1
Y954H60	7776-25aa x Y854	7,030	23.27	15.09	0.0	148	95.0	2.0
US H11	L786442	6,836	23.35	14.64	0.7	149	93.8	2.3
MEAN		8,071	26.21	15.40	3.5	147	95.5	1.9
LSD (.05)		NS	NS	0.95	6.4	NS	2.0	NS
C.V. (%)		12.4	11.20	4.40	129.1	12	1.5	30.8
F value		1.4NS	1.5NS	2.1**	4.6**	1.1NS	5.0**	1.4NS

TEST B390. CODED VARIETY TRIAL: AREA 5, BRAWLEY, CA., 1989-90

23 entries X 10 reps, RCB
1-row plots, 40 ft. long

Planted: September 19, 1989
Harvested: May 21-22, 1990

Code	Variety	Source	Acre Yield		Sucrose	Bolters	Beets/ 100'	Clean Beets	Nitrate Nitrogen
			Sugar Lbs	Beets Tons	%	%	No.	%	Rating
A5-07	9BG6372	Betaseed	10,323	34.21	15.08	0.9	132	95.3	1.6
A5-15	87C40-010	Holly	9,844	32.58	15.10	0.5	132	94.4	1.7
A5-21	87C40-07	Holly	9,623	33.03	14.57	0.3	126	95.0	1.5
A5-10	86-84C80-019	Holly	9,494	31.04	15.30	1.3	131	96.2	1.8
A5-19	87C40-09	Holly	9,422	31.61	14.91	1.0	121	94.2	1.4
A5-04	87C40-011	Holly	9,312	30.97	15.05	1.8	132	94.7	1.5
A5-02	HH51	Holly	9,266	31.24	14.83	0.0	123	96.7	1.8
A5-18	86C15-016	Holly	9,204	29.80	15.46	1.7	133	96.0	1.6
A5-23	HMI-3009	Mono-Hy	9,147	29.46	15.55	5.3	131	95.9	1.6
A5-17	HH61	Holly	9,102	29.44	15.46	0.5	124	96.2	1.7
A5-16	87C40-08	Holly	8,962	30.84	14.51	1.3	121	94.7	1.4
A5-20	H86519	Spreckels	8,900	29.50	15.09	4.3	124	96.1	1.7
A5-03	87C40-012	Holly	8,726	28.85	15.13	0.5	131	95.5	1.5
A5-08	HH41	Holly	8,714	30.16	14.46	0.7	130	95.8	1.6
A5-09	H87545	Spreckels	8,446	28.01	15.11	4.6	137	95.8	1.5
A5-11	8BG6332	Betaseed	8,358	27.53	15.19	0.3	135	95.3	1.3

TEST B390. CODED VARIETY TRIAL: AREA 5, BRAWLEY, CA., 1989-90
(continued)

Code	Variety	Source	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Beets/ 100' No.	Clean Beets %	Nitrate Nitrogen Rating
A5-01	8BG6132	Betaseed	8,287	27.48	15.09	4.1	129	93.5	1.4
A5-05	HH52	Holly	8,146	27.82	14.63	0.7	129	95.8	1.2
A5-14	HH37	Holly	8,036	26.90	14.95	0.6	130	95.7	1.7
A5-22	SS-NB3	Spreckels	7,891	26.60	14.84	0.0	125	95.1	1.6
A5-12	H86460	Spreckels	7,872	26.25	15.00	2.7	126	96.0	1.7
A5-06	US H11	Check	7,820	26.89	14.55	0.4	128	93.3	1.6
A5-13	6BG6165	Betaseed	7,510	25.21	14.91	0.4	121	93.6	1.6
MEAN			8,800	29.37	14.99	1.5	128	95.3	1.5
LSD (.05)			608	1.92	0.46	1.6	NS	1.4	NS
C.V. (%)			7.8	7.40	3.40	123.7	10.1	1.7	41.5
F value			11.2**	11.80**	3.46**	7.2**	1.2NS	3.4**	0.5NS

TEST B190. EFFECTS OF PLANTING AND HARVEST DATES AND VARIETIES ON LIYV INFECTION AND SUGAR YIELD PERFORMANCE IN IMPERIAL VALLEY, 1989-90.

8 treatments (4 planting dates x 2 varieties) in RCB x 3 dates in split-block x 6 replications

	Acre Yield		%	%	Beets/	LIYV
	Sugar lbs/a	Beets t/a	Sucrose	Bolters	100 ft No.	Inf. %
Treatment						
Varieties						
US H11	7967	28.0	14.3	0.6	196	31
HH 41	9336	31.7	14.8	0.7	194	21
Planting Date						
8/29/89	10976	38.5	14.3	1.4	188	35
9/19/89	10159	35.7	14.2	1.3	196	31
10/10/89	8967	30.0	14.9	0.0	250	27
10/31/89	4504	15.1	14.8	0.0	145	10
Harvest Date						
4/19/90	7253	25.4	14.2	0.0	186	--
5/19/90	8648	29.8	14.6	1.2	201	--
6/19/90	10054	34.2	14.8	0.7	198	--
Grand mean	8652	29.8	14.5	0.7	195	26
LSD(.05) Varieties	552	1.9	0.3	---	---	--
LSD(.05) Plant Date	781	2.7	0.5	0.9	21.5	--
LSD(.05) Harvest Date	641	2.7	0.4	1.0	8.1	--
C.V.(%) V x P x H	12.1	12.5	5.2	227.4	12.9	--
F value Varieties	25.3**	15.1**	10.9**	0.3NS	0.03NS	--
F value Plant Date	112.3**	122.2**	4.3*	5.9**	33.5**	--
F value V x P	1.7NS	1.1NS	0.7NS	0.7NS	0.7NS	--
F value Harvest Date	47.4**	27.1**	4.8*	4.2*	9.5**	--
F value V x H	0.4NS	0.1NS	1.6NS	1.2NS	0.4NS	--
F value P x H	4.6**	4.0**	2.0NS	3.1**	0.8NS	--
F value V x P x H	4.1**	2.9*	0.7NS	0.8NS	1.4NS	--

TEST B190. EFFECTS OF PLANTING AND HARVEST DATES AND VARIETIES ON LIYV INFECTION AND SUGAR YIELD PERFORMANCE IN IMPERIAL VALLEY, 1989-90.

(continued)

Treatment	Na	K	NH_2-N	Imp. Value	Recov. Sugar
Varieties	ppm	ppm	ppm		%
US H11	339.7	2524	442.5	11703	87.6
HH 41	375.4	2479	364.1	10970	88.8
Planting Date					
8/29/89	359.0	2441	420.6	11355	87.9
9/19/89	325.2	2471	422.5	11329	87.9
10/10/89	318.2	2454	423.5	11271	88.6
10/31/89	427.9	2640	346.6	11392	88.3
Harvest Date					
4/19/90	348.5	2777	399.6	11957	87.3
5/19/90	320.7	2447	393.8	10981	88.6
6/19/90	403.6	2281	416.5	11071	88.7
Grand mean	357.6	2502	403.3	11337	88.2
LSD(.05) Varieties	32.4	--	39.4	777.4	1.0
LSD(.05) Plant Date	45.9	--	55.7	--	--
LSD(.05) Harvest Date	53.1	237.0	--	--	1.4
C.V.(%) V x P x H	30.1	16.8	23.6	17.7	2.7
F value Varieties	5.0*	0.3NS	16.3**	3.7NS	6.5*
F value Plant Date	9.8**	1.4NS	3.8*	0.02NS	0.4NS
F value V x P	2.3NS	0.8	0.4NS	0.3NS	0.4NS
F value Harvest Date	6.3*	11.3**	0.7NS	2.3NS	3.3NS
F value V x H	0.1NS	0.7NS	1.9NS	1.1NS	1.7NS
F value P x H	5.2**	0.3NS	1.3NS	0.4NS	0.6NS
F value V x P x H	1.1NS	1.0NS	1.3NS	0.9NS	0.7NS

TEST B690. HYBRID SCREEN OF PRELIMINARY LINES FOR RESISTANCE TO LIYV
BRAWLEY, CA., 1989-90

16 entries x 4 reps, RCB
1-row plots, 24 ft. long

Planted: September 20, 1989
Harvested: May 23, 1990

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Bolters %	Beets/ 100' No.	Clean Beets %	Nitrate Nitrogen Rating
Exp. H-8	Accession - 8	10,216	32.43	15.75	2.1	156	94.9	2.3
Exp. H-6	Accession - 6	9,608	31.50	15.20	0.0	153	96.0	2.2
Exp. H-3	Accession - 3	9,589	30.67	15.65	0.8	160	96.1	2.3
HH41	L 41138 Holly	9,488	31.18	15.23	0.0	156	96.6	2.1
Exp. H-9	Accession - 9	9,484	30.00	15.80	1.3	158	95.9	2.1
9911H118	8855aa x 8911	9,350	29.12	16.05	2.3	149	96.0	2.1
Exp. H-7	Accession - 7	9,261	30.27	15.28	1.6	138	95.4	2.1
Exp. H-4	Accession - 4	9,072	29.25	15.52	0.6	153	95.8	2.1
9887H45	8909aa x RZM 8850-63	9,069	28.47	15.96	2.4	145	95.0	2.2
9859H45	8909aa x 8850-58	9,055	28.68	15.76	0.6	144	95.7	2.0
SS NB3	9/89 Spreckels	8,737	29.11	15.03	0.0	152	94.3	2.3
9866H45	8909aa x 8853-56	8,574	26.58	16.05	2.2	139	93.9	2.2
Exp. H-2	Accession - 2	8,423	26.49	15.86	0.6	139	96.9	1.6
Exp. H-5	Accession - 5	8,356	26.31	15.88	13.5	146	94.2	2.0
US H11	L 786442	8,293	28.32	14.69	0.0	146	93.2	1.8
9876H45	8909aa x 8860-63	7,893	25.31	15.59	0.7	142	95.3	2.7
MEAN		9,029	28.98	15.58	1.8	149	95.3	2.1
LSD (.05)		1,021	2.8	0.8	4.2	NS	NS	NS
C.V. (%)		7.9	6.8	3.5	160.7	7.3	1.7	24.0
F value		2.8**	4.3**	2.1**	4.9**	1.7NS	1.6NS	0.9NS

TEST RZM 190-3. RHIZOMANIA EVALUATION OF C0:C1:C2:C3:C4:C5 SYNTHETICS OF Y39 & Y47
SALINAS, CA., 1990

16 entries x 8 replications, RCB (equal)
1-row plots, 16 ft. long

Planted: May 16, 1990
Harvested: November 26, 1990

Variety	Cycle	Description	Acre Yield Sugar lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %	Clean Beets %	Bolting %
US H11		786442	1018	6.2	8.0	210	64.9	64.9	0.0
Rhizosen		Holly 49302	3884	14.6	13.3	223	75.9	79.3	0.0
Rima		SES (3/15/89)	4177	14.9	14.0	206	74.0	80.1	0.0
Y939 (Iso)	-	YR-ER-PMR Y739	2868	10.4	13.8	207	75.3	76.0	0.0
Y439	C0	Inc. Y339 (Iso)	2658	9.6	13.7	198	74.9	71.6	0.5
R639 (Sp)	C1	Inc. R539 (1,1*)	3730	12.9	14.4	207	77.0	77.7	0.0
R739C2(Iso)	C2	Inc. R639 (Iso)	3539	13.4	13.2	207	75.0	78.1	0.0
R739C3(Iso)	C3	RZM R639 (Iso)	4320	15.0	14.4	208	78.2	78.1	0.0
R839C4	C4	RZM R739 (3)	4873	17.4	14.0	222	76.6	82.5	0.7
R939C5	C5	RZM R839C4	4783	16.7	14.3	218	75.4	81.1	0.0
Y547	C0	YR-ER-PMR Y347	1972	9.2	10.7	220	70.0	75.6	0.0
R647 (Iso)	C2	RZM R547	3468	13.8	12.5	216	74.7	76.8	0.0
R747 (Iso)	C3	RZM R647 (Iso)	3207	12.9	12.5	209	74.9	76.1	0.0
R847 (Iso)	C4	RZM R747	3502	13.4	13.1	211	75.4	80.6	0.0
R947C5(Iso)	C5	R847C4	3519	13.9	12.6	231	74.4	78.9	0.0
Y947 (Iso)	-	YR-ER-PMR Y747	2510	10.0	12.4	203	72.4	72.6	0.0
MEAN			3377	12.76	12.95	212	74.31	76.87	0.1
LSD (0.5)			472	1.65	0.61	NS	2.33	4.82	NS
C.V. (%)			14.1	13.05	4.79	14.4	3.16	6.33	623.6
F value			35.8**	25.5**	55.0**	NS	14.0**	6.3**	1.6NS

TEST RZM 190-4. RHIZOMANIA EVALUATION OF RESISTANT LINES, SALINAS, CA., 1990

32 entries x 4 replications, RCB
1-row plots, 16 ft. long

Planted: May 16, 1990
Harvested: November 27, 1990

Variety	Description	Acre Yield		Sucrose	Beets/ 100'	RJAP	Clean Beets	Bolting
		Sugar Lbs	Beets Tons	%	No.	%	%	%
US H11	786442	907	4.9	9.1	213	65.1	52.59	0.0
Rhizosen	Holly 49302 (12/88)	3623	13.4	13.6	173	77.4	72.13	0.0
Rizor-3	SES (1987)	3724	14.0	13.4	202	73.8	77.63	0.0
Rima	SES (1989)	4216	15.0	14.1	195	74.9	73.82	0.0
4581	Betaseed (2/21/90)	3366	12.6	13.4	200	77.3	73.17	0.0
R939C5	RZM R839C4	4952	16.5	15.0	216	78.1	77.01	0.0
R947C5	RZM R847C4	3240	12.0	13.6	219	75.4	73.87	0.0
R920	RZM R820	2961	13.1	11.4	203	70.4	71.77	0.0
R903	RZM R803	3586	15.1	11.9	189	71.7	75.19	1.7
R913	RZM R813	3686	12.8	14.4	188	74.7	64.76	0.0
R904	RZM Rovigo Acc.	2797	13.2	10.9	192	69.7	59.65	1.6
U86-37	Inc. C37 (86443)	1595	6.7	11.9	211	70.5	72.21	0.0
R979	Inc. R879	2693	9.3	14.3	211	74.7	65.50	0.0
R928C1	RZM 8228	2612	10.8	12.1	195	73.3	61.67	0.8
R921	RZM R821	2456	9.1	13.5	200	71.4	61.38	0.0
R918	RZM R818	3216	12.5	12.8	181	72.3	63.46	0.9
R922(R)	RZM R722	3600	14.7	12.3	184	72.0	67.83	0.0
Y954(Sp)	Inc. Y854	1719	7.2	11.8	166	70.8	63.50	0.0
R980	RZM 8244	3573	12.8	14.0	186	75.3	73.19	0.0
F86-31/6	Inc. C31/6 (86263)	1829	8.0	11.4	172	69.6	70.50	0.0

TEST RZM 190-4. RHIZOMANIA EVALUATION OF RESISTANT LINES, SALINAS, CA., 1990
(continued)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %	Clean Beets %	Bolting %
R976	RZM R876	4774	16.6	14.5	184	76.7	82.22	0.0
U86-92	Inc. C92 (86165)	2318	9.0	13.0	163	72.0	61.14	0.0
R977	RZM R877	3692	12.3	14.9	175	77.5	72.56	0.0
U86-46/2	Inc. C46/2 (86342)	1647	6.9	11.6	189	71.0	62.68	0.0
R978C2	RZM R878	4794	15.6	15.2	213	77.6	73.87	0.0
N911	RZM 8201,2	2775	13.1	10.5	202	70.4	71.59	0.0
N941	RZM 8205,6	3171	14.8	10.8	181	71.0	72.54	0.0
R929C1	RZM 8229	3597	14.3	12.4	173	72.4	63.52	0.0
9912	RZM 8909-8911	5199	19.1	13.6	197	77.0	74.22	0.0
9903	YR-ER-PMR 7903 (A,aa)	1518	7.6	9.9	189	69.1	68.78	0.0
9911(Sp)	8911aa x A	3595	14.6	12.6	189	70.0	75.47	0.0
9910(Sp)	8910aa x A	3872	15.6	12.6	181	74.1	82.95	0.0
MEAN		3166	12.29	12.70	192	73.03	69.76	0.2
LSD (.05)		916	3.25	1.41	36.2	4.09	10.09	1.1
C.V. (%)		21.3	18.83	7.90	13.4	3.98	10.30	496.7
F value		9.9	8.69	9.28	1.3	4.68	3.64	1.3

TEST 3490. RHIZOMANIA EVALUATION OF RESISTANT LINES, SALINAS, CA., 1990

32 trmts x 8 reps, RCB
1-row plots, 17 ft. long

Planted: June 5, 1990
Harvested: November 5-6, 1990

Variety	Description	Acre Yield Sugar lbs	Acre Yield Beets Tons	Sucrose %	Root Rot %	Beets/ 100' No.	RJAP %	Powdery Mildew Rating
Rizor-3	SES (1987)	5437	19.09	14.29	0.0	201	77.6	6.4
Rima	SES (1989)	5225	17.36	15.09	0.0	198	77.6	6.9
R978C2	RZM R878	5022	17.14	14.75	0.0	167	79.8	4.1
R928C1 (C28)	RZM 8228 (C37 x PI07)	4973	19.23	12.93	0.0	176	76.9	4.8
R922R	RZM R722	4971	18.97	13.18	0.0	189	75.0	5.8
R939C5 (C39R	RZM R839C4	4755	16.26	14.86	0.0	204	82.1	2.8
9910	8910aa x A	4709	17.93	13.18	0.0	162	77.9	5.9
R970	RZM R871-R880	4583	15.50	14.77	0.0	196	79.6	4.8
R980	RZM 8244	4561	15.61	14.60	0.0	187	79.6	4.8
9911	8911aa x A	4505	16.39	13.81	0.0	187	77.9	4.1
R929C1	RZM 8229 (747aa x PI07)	4435	16.26	13.81	0.0	173	76.9	4.1
R903	RZM R803 (Alba)	4359	15.83	13.89	0.0	183	76.2	4.4
R920 (C94)	RZM R820	4331	16.03	13.57	0.0	173	76.5	4.9
R976	RZM R876	4308	14.89	14.52	0.0	190	78.9	4.3
R921 (C48)	RZM R821 (C37 x WB41,42)	4305	15.86	13.52	0.0	199	74.3	6.7
9912	RZM 8908-8911	4252	15.86	13.52	0.0	195	77.4	5.8
Rhizosen	Holly 49302 (12/88)	4231	15.36	13.81	0.0	198	78.2	5.3
R947C5 (C47R	RZM R847C4	4208	14.64	14.43	0.0	209	79.8	5.3
R904	RZM Rovigo Acc.	4106	16.96	12.19	0.0	171	75.7	4.0
4581	Betaseed (2/21/90)	3985	13.70	14.70	0.0	201	79.5	4.6

TEST 3490. RHIZOMANIA EVALUATION OF RESISTANT LINES, SALINAS, CA., 1990
(continued)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Root Rot %	Beets/ 100' No.	RJAP %	Powdery Mildew Rating
R722 (C50)	Inc. F2 (Y54 x Bm)	3903	15.02	12.99	0.0	201	73.3	4.5
Y747 (C47)	YR-ER-PMR Y547	3664	12.88	14.32	0.0	199	76.8	3.3
Y639 (C39)	Inc. Y539	3644	12.28	14.99	0.0	180	77.6	2.3
R979	Inc. R879	3375	12.46	13.48	0.0	184	77.1	4.7
U86-46/2	Inc. C46/2 (86342)	3343	11.71	14.38	0.0	193	76.6	3.1
9903	YR-ER-PMR 7903 (A,aa)	3292	11.95	13.79	0.0	193	77.4	3.7
U86-37	Inc. C37 (86443)	2950	11.16	13.30	0.0	227	76.4	5.5
N941	RZM 8205,6 (747aa x B883)	2839	11.81	12.10	0.0	169	75.4	6.4
Y954 (C54)	Inc. Y854	2777	9.88	14.02	0.0	176	76.7	3.4
N911	RZM 8201,2 (R76 x B883)	2740	12.48	11.27	0.0	187	73.3	5.9
F86-31/6	Inc. C31/6 (86263)	2737	9.79	13.91	0.0	209	77.2	3.1
US H11	786442	2606	10.91	11.98	0.0	176	74.9	5.7
MEAN		4035	14.72	13.75	0.0	189	77.2	4.7
LSD (.05)		643	2.45	0.69	0.0	28	2.8	0.9
C.V. (%)		16.2	16.9	5.1	0.0	15.2	3.7	18.4
F value		12.0	9.2	14.1	0.0	2.0	3.8	15.1

RZM 190-5. RHIZOMANIA AND YIELD EVALUATION OF LINES AND POPULATIONS
SALINAS, CA., 1990

24 entries x 8 reps, RCB
1-row plots, 16 ft. long

Planted: July 16, 1990
Harvested: November 28, 1990

Variety	Description	Acre Yield		Sucrose	Beets/ 100'	RJAP	Clean Beets	Bolting
		Sugar Lbs	Beets Tons	%	No.	%	%	%
US H11	786442	830	4.1	10.1	254	67.8	63.43	0.0
Rima	SES (1989)	1797	6.8	13.3	234	71.1	59.32	0.0
Rhizosen	Holly 49302 (12/88)	1753	7.1	12.3	234	73.4	68.93	0.0
Y954	Inc. Y854 (C54)	905	3.8	12.0	213	70.0	62.45	0.0
R080	RZM R980	1752	6.7	13.1	220	73.2	62.75	0.0
R722	Inc. F_2(Y54xB.m.)	1060	4.9	10.8	222	68.8	54.07	0.3
R922R	RZM R722	1883	8.5	11.1	220	69.9	57.34	0.0
R022R	RZM R922R	1865	8.2	11.4	239	70.3	55.94	0.0
R022Y	Inc. R922Y & S	1066	4.8	11.0	230	69.9	49.52	0.0
R039C6	RZM R939C5	2248	8.6	13.1	190	72.7	63.96	0.0
R047C6	RZM R947C5	1614	6.5	12.5	232	72.7	70.69	0.0
R020	RZM R920	1717	7.7	11.2	214	71.2	67.01	0.0
R004	RZM R904 (Rovigo Acc.)	1549	8.1	9.6	213	67.6	59.49	0.0
N012	NR-RZM 9201,2	1762	7.5	12.0	228	71.7	70.06	0.0
N042	NR-RZM 9205-8	1807	7.3	12.4	223	72.6	70.49	0.0
U86-37	Inc. C37 (86443)	606	2.7	11.2	239	71.4	55.09	0.0

RZM 190-5. RHIZOMANIA AND YIELD EVALUATION OF LINES AND POPULATIONS
SALINAS, CA., 1990

(continued)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %	Clean Beets %	Bolting %
R079	RZM R979	1076	4.3	12.4	242	72.3	58.06	0.0
R028	RZM 9221 (BC_1)	1474	6.3	11.8	217	71.7	58.89	0.0
R030	RZM 9225 ($F_1 x F_1$)	1629	6.6	12.3	259	72.1	64.00	0.0
5747	4747aa x A	853	4.0	11.0	216	72.7	52.32	0.0
0910	RZM 9910H47	1600	6.5	12.2	214	72.0	64.53	0.0
R029	RZM 9223 (BC_1)	1519	6.5	11.8	219	70.1	59.86	0.0
R031	RZM 9226 ($F_1 x F_1$)	1954	7.6	12.9	227	73.3	63.13	0.0
0911	RZM 9911	1689	6.8	12.4	217	71.1	61.60	0.3
MEAN		1500	6.33	11.83	226	71.23	61.37	0.0
LSD		256	1.09	0.83	31.7	3.32	11.73	0.3
C.V. (%)		17.3	17.49	7.14	14.2	4.72	19.36	983.2
F value		21.3	17.55	10.11	1.7	1.91	1.86	1.0

TEST RZM 290-3. PERFORMANCE OF LINES UNDER RHIZOMANIA
SALINAS, CA., 1990

32 entries x 6 reps, RCB
1-row plots, 13 ft. long

Planted: July 31, 1990
Harvested: December 3, 1990

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %	Clean Beets %
US H11	786442	627	3.11	10.1	206	64.3	53.97
Rima	SES (1989)	1791	6.53	13.7	277	71.6	68.33
Rhzosen	Holly 49302 (12/88)	1866	7.21	12.9	263	74.1	69.81
4581	Betaseed (2/21/90)	1420	5.54	12.8	244	73.9	57.15
R020	RZM R920	1747	7.68	11.4	263	70.2	70.47
Y939	YR-ER-PMR Y739	1036	4.08	12.7	226	73.2	60.38
R939C5	RZM R839C4	1942	7.25	13.4	244	73.6	68.00
R039C6	RZM R939C5	1826	7.05	12.9	223	72.5	65.82
Y947	YR-ER-PMR Y747	1098	4.22	13.0	186	73.5	61.92
R947C5	RZM R847C4	1988	7.85	12.9	229	73.5	65.65
R047C6	RZM R947C5	1708	6.85	12.5	291	72.4	71.06
R004	RZM R904	1293	6.25	10.3	222	69.9	53.60
R007	5747aa x R905R	1375	5.60	12.2	233	71.6	57.89
R008	9911aa x R905rr	1557	6.38	12.2	247	70.6	55.48
Z010H12	9912aa x Polish(C)	1514	5.67	13.4	265	74.6	66.05
Z010H111	9859H6aa x Polish(C)	1239	4.67	13.3	215	73.0	65.10
9903	YR-ER-PMR 7903	837	3.67	11.4	185	68.4	58.60
0911(Iso)	RZM 9911	1522	6.12	12.4	254	73.4	65.58
0913(Iso)	RZM 9911H49	1421	5.73	12.4	220	71.3	62.47
0914	RZM R939/4H44	1282	5.34	12.0	213	71.3	70.40

TEST RZM 290-3. PERFORMANCE OF LINES UNDER RHIZOMANIA
SALINAS, CA., 1990

(continued)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %	Clean Beets %
U86-37	Inc. C37 (86443)	531	2.45	10.9	224	65.2	60.15
R079	RZM R979	1239	4.72	13.1	245	75.2	64.53
Y931	Inc. Y731	800	3.42	11.6	196	67.8	63.15
R076	RZM R976	1489	6.67	11.1	219	72.1	67.01
Y846(Sp)	Inc. Y746	832	3.34	12.3	187	71.9	57.60
R078	RZM R978C2	1481	5.61	13.2	243	73.0	68.76
Y054(Iso)	BYV-ER-PMR Y854	708	2.90	12.1	208	71.4	57.16
R080	RZM R980	1655	6.68	12.4	247	72.7	66.35
R722	Inc. F_2 (Y54 x B.m.)	909	4.36	10.4	234	66.5	54.20
R922R	RZM R722	1553	7.30	10.6	228	67.1	58.39
R022R	RZM R922R	2054	9.36	11.0	242	67.8	68.64
R022Y	Inc. R922 Y&S	1032	4.40	11.6	219	73.0	55.22
MEAN		1355	5.56	12.13	231	71.27	62.78
LSD (.05)		266	0.98	0.99	39.1	4.12	10.41
C.V. (%)		17.2	15.38	7.15	14.8	5.07	14.54
F value		19.4	22.67	8.00	3.4	3.57	2.20

TEST 3290. CBGA-BSDF RHIZOMANIA YIELD TEST, SALINAS, CA., 1990

32 entries x 8 reps, RCB
1-row plots, 37 ft. long

Planted: June 5, 1990
Harvested: November 1-2, 1990

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Root Rot %	Beets/ 100' No.	RJAP %	Powdery Mildew Rating
9911H118	8855aa x 8911	5470	19.47	14.07	0.0	190	78.8	4.9
R939/4H121	8862aa x R839C4	5330	18.95	14.16	0.0	191	79.4	3.6
R939C5	CYCLE 5 RZM SEL. Y39	5300	18.39	14.46	0.0	194	79.9	1.4
RIMA	SES (3/15/89)	5231	17.52	15.02	0.0	206	77.3	6.1
SS-4		5218	17.69	14.76	0.0	203	79.3	4.4
BS-1		5116	18.31	14.04	0.0	169	80.0	3.8
HS-3		5023	17.38	14.52	0.0	181	80.5	4.9
R970H20	C309H3 x R870-#	4957	18.02	13.81	0.0	194	79.0	6.6
HM-6		4934	17.75	14.01	0.0	185	79.9	3.7
SS-6		4882	17.75	13.80	0.0	166	79.1	4.5
BS-5		4870	17.35	14.16	0.0	207	78.9	3.7
BS-3		4870	17.31	14.13	0.0	171	79.7	6.2
SS-7		4867	17.38	14.02	0.0	215	77.5	8.0
BS-2		4851	16.42	14.62	0.0	196	82.5	3.7
SS-5		4773	17.15	13.93	0.0	182	78.2	5.1
BS-4		4742	16.49	14.46	0.0	211	80.5	3.7
HM-1		4610	16.81	13.79	0.0	191	79.4	6.1
AC-1		4410	16.44	13.48	0.0	181	79.1	4.2
HM-5		4246	14.76	14.47	0.0	178	79.1	3.9
HS-2		4178	15.60	13.37	0.0	141	78.2	6.3

TEST 3290. CBGA-BSDF RHIZOMANIA YIELD TEST, SALINAS, CA., 1990

(continued)

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Root Rot %	Beets/ 100' No.	RJAP %	Powdery Mildew Rating
HM-3		4162	15.13	13.79	0.0	190	79.4	4.8
AC-2		4003	14.23	14.20	0.0	160	79.4	5.1
Rhizosen	Holly (12/1/88)	3998	14.85	13.51	0.0	183	79.1	5.5
SS-2		3953	14.01	14.27	0.0	122	78.3	6.5
SS-8		3889	13.99	14.02	0.0	170	78.3	5.0
HM-4		3847	14.83	13.14	0.0	193	77.8	4.4
HM-2		3675	12.67	14.65	0.0	186	80.1	4.2
SS-1		3628	13.68	13.31	0.0	135	77.4	6.6
FD-1		3543	13.21	13.43	0.0	171	77.2	5.1
SS-3		3500	12.92	13.60	0.0	168	77.8	6.6
FD-2		3331	12.74	13.10	0.0	160	77.1	3.9
US H11	C546H3 x C36	2772	11.61	12.16	0.0	183	77.2	5.9
MEAN		4443	15.96	13.95	0.0	180	78.9	4.9
LSD (.05)		594	2.08	0.47	0.0	23	2.2	0.8
C.V. (%)		13.6	13.2	3.4	0.0	13.0	2.8	15.8
F value		10.5	7.9	11.9	0.0	6.5	2.4	22.7

TEST RZM 190-2. RHIZOMANIA EVALUATION OF SUGARBEET x B.MARITIMA LINES
SALINAS, CA., 1990

8 entries x 8 replications, RCB
1-row plots, 16 ft. long

Planted: May 16, 1990
Harvested: November 26, 1990

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %	Clean Beets %	Bolting %
U86-37	Inc. C37 (86443)	1598	6.9	11.4	231	73.1	68.6	0.0
R925	RZM R825	2535	10.1	12.5	207	72.4	69.3	0.0
R924	RZM R824	2856	10.9	13.1	222	73.9	63.5	0.0
R980	RZM 8244-#	4147	15.3	13.5	209	77.6	73.5	0.0
Y954	Inc. Y854 (C54)1	1745	7.9	11.0	186	72.8	71.0	0.0
R722	Inc. F_2 (Y54 x B.m.)	2417	11.4	10.5	203	68.6	63.6	1.9
R922Y	BYVR R722	2948	12.7	11.6	201	72.5	64.4	0.7
R922R	RZM R722	4029	18.1	11.1	213	71.1	72.7	1.5
MEAN		2784	11.68	11.83	209.0	72.75	68.33	0.5
LSD (.05)		395	1.47	0.87	23.2	2.25	8.12	1.2
C.V. (%)		14.1	12.50	7.30	11.0	3.08	11.83	238.2
F value		45.4	51.76	12.83	2.8	10.17	2.01	3.3

TEST RZM 190-6. EVALUATION OF WHITNEY'S SUGARBEET x BETA MARITIMA POPULATIONS
SALINAS, CA., 1990

12 entries x 4 replications, RCB*
1-row plots, 34 ft. long

Planted: July 16, 1990
Harvested: November 29, 1990

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %	Clean Beets %
I-89	WB 169 (1-10)	1364	5.0	13.6	180	70.0	65.27
I-90	WB 169	1275	4.8	13.2	181	69.9	69.71
II-89	WB 258 (11-20)	1669	5.7	14.6	187	72.4	76.01
II-90	WB 258	1670	5.8	14.5	179	72.6	67.29
III-89	WB 151-52 (21-30, 31-40)	1367	4.8	14.2	194	69.5	62.25
III-90	WB 151-52	1516	5.3	14.3	193	71.7	73.28
IV-89	WB 151-39 (41-50, 51-60)	1447	4.7	15.4	195	73.0	57.54
IV-90	WB 151-39	1639	5.5	14.8	189	71.4	83.34
V-89	Composite of I thru IV above.	1351	4.7	14.4	221	71.2	65.53
V-90	Composite 169, 258, 151	1588	5.5	14.4	197	71.5	66.49
US H11	US H11	569	2.5	11.8	265	65.8	65.44
Rima	Rima	1838	6.2	14.9	218	72.2	80.15
MEAN		1441	5.05	14.17	200	70.94	69.36
LSD (.05)		302	1.05	0.80	36.7	2.63	12.36
C.V. (%)		14.6	14.41	3.90	12.8	2.58	12.39
F value		9.4	6.77	11.38	3.7	4.69	3.06

TEST RZM 290-1. YIELD UNDER RHIZOMANIA OF LINES DERIVED FROM PI206407
SALINAS, CA., 1990

8 entries x 6 reps, RCB
1-row plots, 13 ft. long

Planted: July 31, 1990
Harvested: December 3, 1990

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %	Clean Beets %
U86-37	Inc. C37 (86443)	651	2.98	10.8	218	67.6	60.28
R079	RZM R979	1187	4.67	12.7	214	71.2	71.88
R028	RZM 9221 (BC_1F_1)	1325	6.18	10.7	240	69.0	60.33
R030	RZM 9225 ($F_1 \times F_1$)	1376	6.05	11.4	251	69.9	65.00
5747	4747aa x A	773	3.49	11.0	226	67.9	64.01
0910 (Iso)	RZM 9910H47	1476	6.41	11.5	215	70.1	72.70
R029	RZM 9223 (BC_1F_1)	1517	6.53	11.6	229	68.9	61.75
R031	RZM 9226 ($F_1 \times F_1$)	1799	7.06	12.7	226	73.3	71.80
MEAN		1263	5.42	11.56	227	69.75	65.97
LSD (.05)		265	1.05	0.64	47.3	2.64	7.47
C.V. (%)		17.9	16.57	4.69	17.8	3.23	9.66
F value		17.3	17.12	12.59	0.6	4.04	4.24

TEST RZM 290-2. YIELD UNDER RHIZOMANIA OF LINES DERIVED FROM B883
SALINAS, CA., 1990

8 entries x 6 reps, RCB
1-row plots, 13 ft. long

Planted: July 31, 1990
Harvested: December 4, 1990

Variety	Description	Acre Yield Sugar Lbs	Acre Yield Beets Tons	Sucrose %	Beets/ 100' No.	RJAP %	Clean Beets %
US H11		701	3.25	10.7	220	67.5	64.53
R978C1	Inc. R878	1517	6.27	12.1	217	72.1	63.81
N911	RZM 8201,2	1661	7.94	10.4	215	69.3	74.10
N012	NR-RZM 9201,2	1749	7.62	11.4	229	72.8	70.40
R039C6	RZM R939C5	2005	7.78	12.9	226	71.1	70.54
0913	RZM 9911H49	1509	5.99	12.6	214	72.7	66.03
N941	RZM 8205,6	1533	7.26	10.6	213	68.5	74.64
N042	NR-RZM 9205,7,8	1689	6.81	12.4	215	72.4	70.72
MEAN		1546	6.62	11.64	219	70.82	69.35
LSD (.05)		227	0.94	0.52	34.65	2.52	7.69
C.V. (%)		12.5	12.14	3.82	13.52	3.04	9.47
F value		22.9	21.79	28.71	0.24	5.56	2.39

BOLTING EVALUATION AND OBSERVATION TEST
SALINAS, CA., 1990

1-row plot, 594 ft. long Planted: December 4, 1989

Variety	Description	Stand Count	Bolting 6/11	7/17	9/6
Hybrids					
US H11	L786442	851	0.4	2.1	3.6
HH37	L37368	846	0.0	2.6	5.6
Y846H20	U87-309H3 x Y746	890	0.0	0.4	1.3
Y846H89	6790-68HO x Y746	804	0.0	0.6	1.6
Y954H20	U87-309H3 x Y854	836	0.0	0.7	1.2
Y954H18	U88-790-68H26 x Y854	821	0.0	1.3	3.8
Y954H89	U88-790-68CMS x Y854	770	0.0	0.8	1.8
Y954H54	8767-46H0 x Y854	799	0.5	6.9	11.4
Multigerm, O.P lines					
Y949	Inc. Y849	676	4.0	18.8	28.0
Y954	Inc. Y854	777	0.9	4.4	7.1
R970	RZM R871-R879	642	4.4	18.5	21.3
R939/4(Sp)	Inc. R839C4	753	4.1	16.9	29.1
Multigerm, S^f, A:aa					
9910 (Sp)	8910aa x A (Composite)	910	1.1	6.7	8.4
9911 (Sp)	8911aa x A (Composite)	837	0.4	2.6	5.5
9912	RZM 8908,9,10,11aa x A (")	632	1.6	8.9	14.1
N902-1	Inc. 8201,2 (R773 x B883)	633	8.8	20.7	23.5
N902-5	Inc. 8205,6 (7909aa x B883)	816	1.5	6.6	9.1
Monogerm, S^f, A:aa					
9859m	8850,1,4,8 mmaa x A	810	6.3	14.4	17.8
9866m	8853,5,6 mmaa x A	761	5.1	20.2	23.4
9867m	8852,7 mmaa x A	845	8.8	21.9	27.2
9876m	8860,1,2,3 mmaa x A	769	2.6	12.4	15.5
9887m	RZM 8850-8863 mmaa x A	793	7.6	21.3	26.5

[1]Selection for NB made from these plots in 1990.

TEST 290. BOLTING EVALUATION AND OBSERVATION OF LINES, SALINAS, CA., 1990

160 entries x 3 replications — Planted: December 4, 1989
1-row plots, 16 ft. long

TEST 2790. POWDERY MILDEW EVALUATION, 1990

192 entries x 2 replications — Planted: April 17, 1990
1-row plots, 20 ft. long

Variety	Description	Stand[1] Count	Bolting 6/14	Bolting 7/17	Bolting 9/6	P.M.[2] Rating	2790 P.M.[3]	2790 D.M.[4]
SP7622-0	L80466 (8/87)	76	48.7	77.6	84.2	3.3	---	---
Y009	Inc. US 22/3	75	77.3	89.3	92.0	3.0	6.4	1.9
768	Inc. 868 (US 75)	67	0.0	3.0	4.5	3.0	5.3	0.0
U86-37	C37, 86443	78	0.0	1.3	2.6	1.7	5.0	3.8
R974	RZM R874	70	4.3	14.3	15.7	1.3	4.5	1.7
R979	Inc. R879	75	12.0	21.3	21.3	1.3	4.3	0.8
R928 (C28)	Inc. (C37 x PI07)	72	44.4	65.3	84.7	1.7	4.5	9.1
R928C1	RZM (C37 xPI07)	75	48.0	73.3	96.0	2.0	4.4	8.8
R921	RZM R821 (C37 x WB41.42)	73	17.8	28.8	32.9	0.7	5.4	5.6
R924	RZM R824 (C37 x WB41)	76	5.3	10.5	17.1	0.7	4.5	6.5
R925	RZM R825 (C37 x WB42)	74	0.0	2.7	4.1	1.0	4.8	3.4
Y854	Inc. Y654	73	0.0	1.4	1.4	0.3	4.1	0.0
Y854 (C54)	YR-ER-PMR Y654	73	0.0	0.0	0.0	1.3	3.3	2.5
Y954 (C54)	Inc. Y854	73	0.0	0.0	1.4	0.7	3.5	2.0
R975	Inc. R875	76	1.3	9.2	13.2	1.7	4.6	2.1
R980	RZM 8244-#'s	72	0.0	4.2	4.2	2.3	4.5	2.6
Y722 (C50)	Inc. F_1&F_2(SB x B.M)	71	45.1	59.2	66.2	0.3	4.5	5.7
R922R	RZM R722	76	30.3	44.7	53.9	0.3	4.9	4.7
R922Y	BYVR R722	76	3.9	17.1	23.7	1.0	4.1	1.5
R922S	BYVR R722 (%S)	71	14.1	21.1	21.1	0.3	5.1	5.8
R918	RZM R818	74	31.1	47.3	54.1	0.0	4.3	0.0
R970	RZM R871-R879,8244	72	18.1	23.6	31.9	2.0	4.1	7.2
U86-46/2	C46/2, 86342	74	0.0	1.4	1.4	0.7	3.6	3.8
Y846	Inc. Y746	66	0.0	0.0	0.0	0.0	2.0	0.0
R973	RZM R873	74	0.0	8.1	12.2	0.3	2.9	2.3
R978C1	Inc. R878	72	0.0	2.8	2.8	0.0	3.0	5.9
R978C2	RZM R878	72	1.4	5.6	6.9	0.0	4.0	5.4
N911	RZM 8201,2	69	15.9	27.5	40.6	3.7	5.1	3.4

TEST 290. BOLTING EVALUATION AND OBSERVATION OF LINES,SALINAS, CA., 1990
TEST 2790. POWDERY MILDEW EVALUATION, 1990

(continued)

Variety	Description	Stand[1] Count	Bolting 6/14	7/17	9/6	P.M.[2] Rating	2790 P.M.[3]	D.M.[4]
N902-1	Inc. 8201,2	61	3.3	6.6	8.2	3.3	5.0	0.9
N902-3	Inc. 8203,4	68	5.9	19.1	25.0	2.7	5.1	4.0
F86-92	Inc. C92	64	0.0	12.5	21.9	1.0	3.3	3.0
R977	RZM R877	70	1.4	31.4	47.1	1.0	4.0	8.5
F86-31/6	Inc. C31/6	67	0.0	4.5	9.0	1.0	3.5	3.1
Y931	Inc. Y731	65	0.0	3.1	3.1	0.3	3.0	2.4
Y931/D	Inc. Y731 - # Davis	69	0.0	0.0	0.0	0.3	2.9	7.2
Y931/S	Inc. Y731 - # Salinas	72	0.0	0.0	0.0	0.0	3.3	3.7
R971	RZM R871	72	0.0	5.6	15.3	1.3	4.0	2.7
R976	RZM R876	73	1.4	6.8	12.3	0.3	3.9	12.3
Y931-10	Inc. Y731-10	73	0.0	0.0	0.0	0.0	2.8	24.0
Y931-43	Inc. Y731-43	69	0.0	0.0	1.4	0.7	4.3	2.3
Y931-71	Inc. Y731-71	70	0.0	2.9	5.7	0.0	2.8	0.7
Y931-75	Inc. Y731-75	74	0.0	0.0	0.0	0.0	2.6	7.4
Y931-89	Inc. Y731-89	72	0.0	0.0	0.0	0.0	3.9	5.9
Y931-94	Inc. Y731-94	74	0.0	1.4	6.8	0.3	2.8	12.5
F86-91	Inc. C91	73	0.0	2.7	5.5	0.0	3.3	3.9
Y941 (C91)	YR-ER-PMR Y741	76	1.3	3.9	6.6	0.0	3.0	3.5
Y948 (C93)	YR-ER-PMR Y748	77	0.0	2.6	6.5	1.0	3.9	0.9
Y949 (C49)	Inc. Y849	69	1.4	2.9	7.2	0.7	2.9	0.8
Y939 (C39)	YR-ER-PMR Y739	74	0.0	5.4	6.8	0.0	2.6	2.7
R939C5 (C39R)	RZM R839C4	74	4.1	9.5	17.6	0.0	1.9	0.0
R939/4	Inc. R839 (C4)	74	0.0	6.8	14.9	0.0	0.6	0.9
R839-6	Inc. R739-6	71	0.0	0.0	2.8	0.0	0.3	0.8
R847	Inc. R747	72	9.7	29.2	40.3	0.7	---	---
R947C5 (C47R)	RZM R847C4	80	1.3	11.3	18.8	0.7	3.8	4.0
Y947 (C47)	YR-ER-PMR Y747	76	0.0	0.0	2.6	0.3	3.4	1.6
Y956	YR-ER-PMR Y756,Y656	79	0.0	1.3	2.5	0.3	3.5	1.7
R903	RZM R803 (Alba)	75	10.7	37.3	49.3	0.3	4.3	1.5
R904	RZM ROV1GO Acc	76	53.9	73.7	73.7	1.0	4.1	3.4
R913	RZM R813	80	2.5	15.0	25.0	0.0	3.0	3.2
R920 (C94)	RZM R820	78	24.4	48.7	55.1	1.7	4.3	2.8
9101 (C11T)	Inc. 8101	65	1.5	3.1	3.1	0.0	2.9	2.6
9102 (C12T)	Inc. 8102	72	0.0	0.0	4.2	0.0	3.0	7.5
U86-37	C37, 86443	77	0.0	1.3	3.9	1.3	---	---
SP 7622-0	L80466 (8/87)	77	57.1	70.1	80.5	3.3	---	---

TEST 290. BOLTING EVALUATION AND OBSERVATION OF LINES,SALINAS, CA., 1990
TEST 2790. POWDERY MILDEW EVALUATION, 1990

(continued)

Variety	Description	Stand[1] Count	Bolting 6/14	7/17	9/6	P.M.[2] Rating	2790 P.M.[3]	D.M.[4]
5747	4747aa x A	67	0.0	3.0	6.0	0.3	4.6	5.2
R929	Inc. (747aa x P107)	74	64.9	82.4	85.1	1.0	4.5	7.0
R929C1	RZM 8229	70	31.4	50.0	52.9	0.0	3.5	7.6
9910	RZM 8910	67	1.5	6.0	6.0	1.3	4.4	6.2
9910	8910aa x A (C)	74	0.0	4.1	5.4	1.3	4.4	1.8
9910H47	5747aa x 8910	76	0.0	6.6	11.8	1.3	4.5	4.2
7903	6903aa x A	68	0.0	2.9	4.4	0.3	4.3	1.6
9903	YR-ER-PMR 7903 (A,aa)	72	0.0	0.0	0.0	0.3	3.4	4.2
8909	7909,7239aa x A	65	0.0	3.1	4.6	0.0	4.1	0.9
9911	RZM 8911	72	0.0	0.0	0.0	0.0	4.4	1.0
9911	8911aa x A	72	1.4	1.4	1.4	0.0	3.8	0.0
9911H49	7903aa x 8911 (C)	67	0.0	1.5	6.0	0.0	3.8	0.0
9912	RZM 8908,11aa x A	73	1.4	6.8	12.3	0.7	4.8	4.2
9907-14	Inc. 7907-# (C)	67	13.4	20.9	23.9	0.0	4.5	14.2
9907-21	Inc. 7907-21-# (C)	71	0.0	1.4	2.8	2.7	6.1	2.9
9908-2	Inc. 8908-2-#-# (C)	62	0.0	3.2	1.6	1.0	5.6	23.4
9908-7	Inc. 7908-7-# (C)	69	0.0	4.3	8.7	1.7	5.6	7.7
9909-13	Inc. 8909-13-#-# (C)	72	4.2	6.9	6.9	1.3	5.6	9.0
9909-14	Inc. 8909-14-#-# (C)	75	10.7	33.3	49.3	0.3	4.4	12.4
9909-16	Inc. 8909-16-#-# (C)	67	34.3	47.8	50.7	1.0	3.6	0.0
N941	RZM 8205,6	68	8.8	19.1	26.5	2.0	5.0	3.0
N902-5	Inc. 8205,6	66	4.5	10.6	13.6	2.0	5.3	1.1
N902-7	Inc. 8207,8	70	2.9	12.9	15.7	1.7	5.3	2.4
N902-3H46	8906aa(RS) x 8203,4,5	68	1.5	5.9	7.4	2.0	5.0	0.8
N902-5H45	8909aa x 8204,6	76	0.0	0.0	2.6	1.3	---	---
R939/4H44	8904aa x R839 (C4)	81	2.5	4.9	8.6	0.3	2.8	0.9
9905	YR-ER-PMR 7905 (A,aa)	73	0.0	4.1	9.6	0.3	3.8	4.4
9902	8902 (C)	73	0.0	0.0	0.0	0.0	3.4	1.2
8755	7755,6aa x A (C310)	74	0.0	5.4	6.8	0.7	4.0	0.9
8787	7755-7797aa x A	75	2.7	6.7	10.7	1.0	4.9	3.3
7767	6767aa x A	71	11.3	14.1	21.1	1.7	3.9	0.0
7776	6776aa x A	75	6.7	18.7	20.0	2.3	4.4	1.8
8790	7790aa x A (C4,Syn 2)	73	0.0	1.4	2.7	1.0	4.3	0.0
8796	7796aa x A (C796)	77	3.9	14.3	14.3	1.0	4.5	1.7
9776-1	Inc. 7776-1	73	0.0	0.0	1.4	1.3	3.8	0.8
9776-20	Inc. 7776-20	71	7.0	12.7	23.9	1.0	4.3	0.0

TEST 290. BOLTING EVALUATION AND OBSERVATION OF LINES,SALINAS, CA., 1990
TEST 2790. POWDERY MILDEW EVALUATION, 1990

(continued)

Variety	Description	Stand[1] Count	Bolting 6/14	7/17	9/6	P.M.[2] Rating	2790 P.M.[3]	D.M.[4]
9776-21	Inc. 7776-21	78	1.3	1.3	1.3	1.3	4.4	1.5
9776-25	Inc. 7776-25	77	1.3	2.6	3.9	1.3	4.5	0.0
9851	RZM 8851	72	1.4	1.4	1.4	3.3	6.3	1.9
9858	RZM 8858	75	0.0	1.3	4.0	2.3	---	---
9859m	8850,1,4,8aa x A (mm)	73	2.7	8.2	9.6	2.7	5.8	5.9
9859H3	562HO x 8850,1,4,8A	70	2.9	10.0	11.4	2.3	5.4	0.0
9859H6	1566aa x 8850,1,4,8A	71	1.4	4.2	7.0	2.0	5.3	2.1
N971	RZM 8209,10	73	4.1	13.7	16.4	4.0	5.9	0.9
9852	RZM 8852	75	1.3	4.0	8.0	2.3	4.9	7.5
9857	RZM 8857	78	3.8	16.7	26.9	2.7	4.4	4.2
9867m	8852,8857aa x A (mm)	78	1.3	12.8	21.8	2.3	4.1	0.8
9867H67	8767aa x 8852,8857	70	4.3	15.7	22.9	1.3	4.1	0.0
9867H68	7767HO x 8852,8857	72	4.2	6.9	6.9	2.0	4.3	0.0
9855	RZM 8855	73	5.5	12.3	19.2	1.3	4.1	5.7
9856	RZM 8856	79	0.0	0.0	1.3	1.3	3.3	1.7
9866m	8853,5,6aa x A (mm)	77	7.8	18.2	24.7	2.3	4.5	0.0
9866H80	8755aa x 8853,5,6	77	1.3	13.0	16.9	1.3	3.8	0.0
9866H81	8755HO x 8853,5,6	75	2.7	17.3	22.7	2.3	4.4	3.3
9865	RZM 8246-#	78	0.0	1.3	6.4	3.0	5.4	0.0
9863	RZM 8863	75	2.7	2.7	6.7	2.3	5.1	0.7
9864	RZM 8247 - #	69	5.8	11.6	17.4	1.3	4.1	0.0
9876m	8860,63aa x A(mm)	71	1.4	5.6	11.3	2.7	4.9	1.9
9876H76	8776aa x 8860,63	70	0.0	1.4	5.7	1.7	5.0	0.0
9876H77	7776HO x 8860,63	72	1.4	9.7	12.5	1.3	4.9	3.4
9876H105	8863HO x 8860,63	71	2.8	8.5	7.0	2.3	4.8	0.9
9887m	RZM8850-8863aa x A	71	9.9	15.5	25.4	2.7	4.6	3.0
9887H77	7776HO x RZM8850-8863	72	2.8	6.9	11.1	1.7	4.9	3.3
9887H86	8787aa x RZM8850-8863	69	10.1	18.8	27.5	2.7	4.6	4.0
F82-546H3	78155, C562HO x C546	71	0.0	0.0	8.5	1.0	5.3	0.0
87-309H37	87242, Wood	75	1.3	1.3	2.7	1.0	4.6	0.9
87-309H3	87671, Wood	72	0.0	0.0	0.0	1.7	5.5	0.8
88-790-68H26	C309CMS x C790-68	80	0.0	3.8	5.0	1.0	5.3	0.0

TEST 290. BOLTING EVALUATION AND OBSERVATION OF LINES,SALINAS, CA., 1990
TEST 2790. POWDERY MILDEW EVALUATION, 1990

(continued)

Variety	Description	Stand[1] Count	Bolting 6/14	Bolting 7/17	Bolting 9/6	P.M.[2] Rating	2790 P.M.[3]	2790 D.M.[4]
88-790-68H92	C796-22CMS x C790-68	75	0.0	1.3	5.3	0.3	4.0	0.0
88-790-68H37	C306CMS x C790-68	70	0.0	0.0	5.7	1.0	3.5	0.0
F82-546	82372, C546	71	1.4	1.4	2.8	2.0	5.5	1.0
F82-562	82196, C562	43	14.0	25.6	37.2	2.7	5.0	2.5
F82-562HO	82196, C562HO	72	2.8	15.3	26.4	2.0	5.4	0.0
83-718	83246, C718	52	0.0	3.8	5.8	0.3	4.6	2.8
87-309	87672, Wood	81	0.0	7.4	9.9	2.7	5.8	0.0
87-309CMS	87670, Wood	79	2.5	16.5	24.1	3.0	5.8	3.2
88-790-68	Inc. C790-68	71	0.0	7.0	7.0	0.0	3.1	0.8
88-790-68CMS	C790-68CMS	76	1.3	9.2	13.2	0.7	3.1	0.0
9554	Inc. 5554 (NB 4)	78	0.0	0.0	2.6	1.3	3.6	0.0
9554H1	8502HO x 5554	66	1.5	7.6	9.1	2.7	4.5	0.9
89-762-17	C762-17	76	0.0	0.0	0.0	0.0	3.0	7.2
89-762-17CMS	C762-17CMS	78	0.0	2.6	3.8	1.0	4.3	1.8
89-312	C312	77	0.0	6.5	9.1	1.7	2.9	0.0
89-312CMS	C312CMS	68	5.9	16.2	19.1	1.7	3.5	1.7
89-313	C313	54	3.7	11.1	11.1	1.0	1.4	6.6
89-313CMS	C313CMS	70	1.4	7.1	12.9	1.3	2.1	0.0
9807	T-O 8807-# (C306)	75	0.0	0.0	0.0	0.0	2.0	1.1
9833	T-O 8833-#	80	0.0	2.5	8.8	1.0	4.1	0.0
7766-23	T-O 6766-23-#	73	4.1	6.8	9.6	3.0	4.3	0.0
9766-23	T-O 8766-23-#	81	0.0	6.2	9.9	3.0	4.4	0.0
7766-62	T-O 6766-62-#	80	0.0	0.0	1.3	3.0	7.0	0.0
9766-62	T-O 8766-62-#	66	1.5	6.1	6.1	2.7	6.4	1.9
8767-46	Inc. 5767-46	77	0.0	6.5	10.4	2.7	4.5	0.0
9767-46	Inc. 8767-46	82	0.0	4.9	8.5	2.0	4.5	0.0
N801A	Inc. B883	55	60.0	100.0	100.0	3.3	---	---
N801B	Inc. EM-NR-87	49	79.6	100.0	100.0	3.0	---	---

[1]Total number of plants over three replications for Test 290.
[2]Mean of powdery mildew ratings made 7/20/90.
[3]Powdery mildew scored on 8/13, 8/20, 8/28 & 9/4/90 where 0 = 0% leaf area infected to 9 = 90-100% covered. Mean approximately equals area under disease progress curve.
[4]% plants with downey mildew scored on 6/12 & 7/5/90.

TEST 490. BOLTING EVALUATION AND OBSERVATION OF HYBRIDS,SALINAS, CA., 1989-90

120 entries x 3 replications
1-row plots, 16 ft. long

Planted: December 4, 1989

TEST 2990. POWDERY MILDEW EVALUATION, 1990

1-row plots, 20 ft. long

Planted: April 17, 1990

Variety	Description	Stand[1] Count	Bolting 6/14	Bolting 7/17	Bolting 9/6	P.M.[2] Rating	2990 P.M.[3]	2990 D.M.[4]
		No.	%	%	%	Avg.		
US H11	L 786442	73	1.4	6.8	9.6	2.0	5.0	1.6
Vyncemono	VDH (3/22/89)	76	0.0	1.3	2.6	0.3	4.9	0.0
Rima	SES (3/15/89)	74	0.0	8.1	9.5	1.3	5.8	2.3
6625	Betaseed (12/88)	74	2.7	5.4	10.8	1.7	---	---
4757	Betaseed (1/6/89)	77	0.0	0.0	1.3	0.7	---	---
SSNB3	Spreckels (1/22/89)	75	0.0	1.3	4.0	1.7	5.0	4.9
HH41	Holly L41330 (4/88)	78	0.0	5.1	10.3	2.3	---	---
Rhizosen	Holly L49302 (12/88)	69	1.4	7.2	15.9	3.3	4.4	0.8
Y846H8	F82-546H3 x Y746	65	0.0	0.0	0.0	2.3	4.0	4.7
Y846H20	87-309H3 x Y746	76	1.3	3.9	5.3	3.0	5.0	4.3
Y846H38	6827HO x Y746	74	0.0	2.7	4.1	0.3	4.3	0.0
Y846H39	6762-17HO x Y746	71	0.0	2.8	4.2	1.0	4.1	0.9
Y846H54	5767-46aa x Y746	64	1.6	4.7	10.9	1.7	4.6	0.0
Y846H66	7766-23HO x Y746	68	0.0	0.0	4.4	0.3	4.3	4.4
Y846H70	7766-62HO x Y746	67	0.0	1.5	1.5	1.0	5.0	8.9
Y846H97	5796-43HO x Y746	60	1.7	1.7	5.0	1.7	4.8	5.4
9101H8	F82-546H3 x 8101	70	1.4	5.7	5.7	1.0	4.4	0.0
9102H8	F82-546H3 x 8102	71	0.0	5.6	12.7	2.3	4.4	1.6
R939/4H8	F82-546H3 x R939 (C4)	75	1.3	4.0	16.0	1.7	4.0	2.4
R939/4H20	87-309H3 x R839 (C4)	72	4.2	18.1	22.2	2.0	4.6	0.8
R970H8	F82-546H3 x RZM R871-R879,8244	75	0.0	4.0	6.7	3.0	5.4	0.8
R970H20	87-309H3 x RZM R871-R879,8244	75	18.7	29.3	32.0	3.7	5.4	3.1
Y949H20	87-309H3 x Y849	73	0.0	4.1	6.8	3.3	4.5	3.8
US H11	L786442	77	2.6	3.9	5.2	2.3	5.8	3.9
N902-5H20	87-309H3 x 8204,6	77	0.0	6.5	11.7	2.7	5.6	2.3
N902-3H26	87-309CMS x 8203,4,5	79	3.8	7.6	12.7	3.0	---	---
N902-1H72	83-718HO x 8201,2	73	5.5	9.6	13.7	3.0	5.0	3.1
N902-7H68	7767HO x 8207,8	69	1.4	5.8	8.7	3.0	---	---

TEST 490. BOLTING EVALUATION AND OBSERVATION OF HYBRIDS,SALINAS, CA., 1989-90
TEST 2990. POWDERY MILDEW EVALUATION, 1990

(continued)

Variety	Description	Stand[1] Count	Bolting 6/14	Bolting 7/17	Bolting 9/6	P.M.[2] Rating	2990 P.M.[3]	2990 D.M.[4]
		No.	%	%	%	Avg.		
N902-5H45	8909aa x 8204,6	71	1.4	2.8	8.5	1.7	---	---
N902-3H46	8906aa x 8203,4,5	79	0.0	10.1	12.7	1.7	4.8	6.8
N902-1H115	8857aa x 8201,2	73	5.5	16.4	19.2	2.3	---	---
N801H(B)	CMS Blend x B883	74	2.7	16.2	28.4	3.0	---	---
9859H45	8909(Sp)(Iso)aa x 8850,1,4,8A	77	0.0	1.3	2.6	3.0	5.5	2.4
9859H46	8906aa x 8850,1,4,8A	75	4.0	10.7	13.3	2.7	4.9	9.3
9866H45	8909(Sp)(Iso) x 8853,5,6	71	1.4	7.0	5.6	3.0	4.9	5.7
9866H46	8906(RS)aa x 8853,5,6	73	4.1	20.5	27.4	2.3	4.5	5.3
9867H45	8909(Sp)(Iso)aa x 8852,8857	68	2.9	17.6	26.5	2.0	4.5	7.0
9867H46	8906(RS)aa x 8852,8857	74	5.4	13.5	24.3	2.7	5.6	12.4
9867H28	6235-14aa x 8852,8857	67	7.5	37.3	43.3	1.3	3.9	9.7
9867H29	6235-21aa x 8852,8857	70	10.0	25.7	31.4	3.0	5.4	3.2
9867H30	7908-2aa x 8852,8857	69	4.3	10.1	18.8	2.3	5.1	6.1
9867H31	6236-7aa x 8852,8857	76	6.6	17.1	34.2	3.0	4.9	5.6
9867H32	6237-13aa x 8852,8857	74	5.4	13.5	13.5	3.0	5.1	4.4
9867H33	6237-14aa x 8852,8857	73	17.8	31.5	35.6	3.0	4.0	9.5
9867H34	6237-16aa x 8852,8857	73	9.6	16.4	20.5	3.0	4.8	8.4
9867H35	7908-16aa x 8852,8857	71	4.2	29.6	36.6	3.3	---	---
9876H45	8909(Sp)aa x 8860,61,62,63	71	1.4	8.5	8.5	2.3	5.5	1.7
9876H46	8906(RS) x 8860,61,62,63	74	5.4	13.5	18.9	2.7	5.3	7.4
9887H45	8909(Sp)(Iso)aa x RZM 8850-8863,8846,7	69	1.4	4.3	7.2	2.0	4.5	4.3
9887H46	8906aa x RZM 8850-8863, 8846,7	75	2.7	9.3	14.7	2.3	5.1	4.3
9912H8	F82-546H3 x RZM 8908,09, 10,11A	74	0.0	2.7	8.1	1.3	5.0	3.4
9912H20	87-309H3 x RZM 8908,09, 10,11A	75	2.7	10.7	10.7	2.3	5.0	2.9
9910H20	87-309H3 x 8910	69	0.0	1.4	7.2	3.0	5.3	4.7
9910H18	88-790-68H26 x 8910	79	0.0	5.1	13.9	2.3	4.9	0.8
9911H20	87-309H3 x 8911	78	0.0	0.0	0.0	3.0	5.6	3.3
9911H18	88-790-68H26 x 8911	77	0.0	0.0	3.9	1.7	4.9	7.0

TEST 490. BOLTING EVALUATION AND OBSERVATION OF HYBRIDS,SALINAS, CA., 1989-90
TEST 2990. POWDERY MILDEW EVALUATION, 1990

(continued)

Variety	Description	Stand[1] Count	Bolting 6/14	Bolting 7/17	Bolting 9/6	P.M.[2] Rating	2990 P.M.[3]	2990 D.M.[4]
		No.	%	%	%	Avg.		
9911H66	7766-23HO x 8911	71	0.0	0.0	4.2	1.7	4.3	5.5
9911H70	7766-62HO x 8911	78	0.0	0.0	1.3	1.3	4.9	6.8
9911H68	7767HO x 8911	77	0.0	0.0	3.9	1.7	---	---
9911H118	8855aa x 8911	74	0.0	4.1	5.4	1.3	5.1	4.5
Y931H8	F82-546H3 x Y731	71	0.0	0.0	1.4	1.0	4.1	5.3
Y931H20	87-309H3 x Y731	75	1.3	2.7	4.0	2.0	4.5	1.5
Y931H38	6827HO x Y731	73	0.0	0.0	1.4	1.0	4.0	4.6
Y931H39	6762-17HO x Y731	71	1.4	5.6	7.0	1.0	3.8	4.7
Y931H40	6830HO x Y731	74	0.0	0.0	0.0	0.3	3.0	4.4
Y931H37	85-306CMS x Y731	81	0.0	3.7	6.2	0.7	3.0	2.4
Y931H89	88-790-68CMS x Y731	73	0.0	2.7	2.7	0.7	4.0	0.9
Y931/SH20	87-309H3 x Y731(S)	75	0.0	1.3	2.7	2.3	4.5	1.6
Y931/SH89	88-790-68CMS x Y731(S)	70	1.4	1.4	2.9	0.7	3.4	1.3
Y931/DH20	87-309H3 x Y731(D)	76	0.0	1.3	7.9	2.0	4.5	1.5
Y931/DH89	88-790-68CMS x Y731(D)	76	0.0	1.3	1.3	1.3	3.9	1.4
US H11	L786442	77	0.0	5.2	7.8	2.7	5.5	3.8
Y954H3	F82-562HO x Y854 (Iso)	72	0.0	0.0	0.0	1.3	4.4	1.4
Y954H8	F82-546H3 x Y854 (Iso)	74	0.0	0.0	4.1	1.7	4.4	0.8
Y954H18	88-790-68H26 x Y854 (Iso)	70	0.0	2.9	2.9	2.3	4.6	1.6
Y954H19	88-790-68H37 x Y854 (Iso)	72	0.0	5.6	6.9	1.3	3.4	4.7
Y954H20	87-309H3 x Y854 (Iso)	73	0.0	0.0	1.4	2.0	5.0	1.7
Y954H23	87-309H37 x Y854 (Iso)	77	0.0	2.6	2.6	2.3	4.6	0.0
Y954H26	87-309CMS x Y854 (Iso)	73	0.0	0.0	2.7	3.3	5.5	0.0
Y954H37	85-306CMS x Y854 (Iso)	72	0.0	1.4	2.8	2.3	3.6	3.3
Y954H38	6827HO x Y854 (Iso)	73	0.0	0.0	1.4	1.0	3.6	2.7
Y954H39	6762-17HO x Y854 (Iso)	73	0.0	0.0	2.7	0.7	3.9	1.6
Y954H40	6830HO x Y854 (Iso)	73	0.0	2.7	4.1	1.7	3.0	1.7
Y954H72	83-718HO x Y854 (Iso)	75	0.0	0.0	2.7	1.0	3.6	0.9
Y954H84	8790-69HO x Y854 (Iso)	77	0.0	0.0	2.6	0.7	4.4	5.0
Y954H85	8790-92HO x Y854 (Iso)	74	2.7	10.8	10.8	0.3	4.1	1.6
Y954H87	6790-55HO x Y854 (Iso)	71	0.0	1.4	1.4	1.0	4.9	0.0
Y954H89	88-790-68CMS x Y854 (Iso)	66	0.0	0.0	0.0	1.3	3.6	1.7
Y954H92	F85-796-22CMS x Y854 (Iso)	70	0.0	0.0	1.4	0.7	4.9	2.4
Y954H50	8767-20HO x Y854 (Iso)	77	0.0	2.6	3.9	1.7	4.1	1.0
Y954H51	8767-27HO x Y854 (Iso)	66	0.0	4.5	7.6	0.7	---	---
Y954H52	8767-30HO x Y854 (Iso)	74	0.0	2.7	8.1	2.3	4.6	1.0

TEST 490. BOLTING EVALUATION AND OBSERVATION OF HYBRIDS,SALINAS, CA., 1989-90
TEST 2990. POWDERY MILDEW EVALUATION, 1990

(continued)

Variety	Description	Stand[1] Count	Bolting 6/14	Bolting 7/17	Bolting 9/6	P.M.[2] Rating	2990 P.M.[3]	2990 D.M.[4]
		No.	%	%	%	Avg.		
Y954H53	8767-44HO x Y854 (Iso)	73	0.0	6.8	9.6	1.7	---	---
Y954H54	8767-46HO x Y854 (Iso)	73	1.4	9.6	12.3	0.7	4.3	3.4
Y954H61	7766-8HO x Y854 (Iso)	69	0.0	1.4	1.4	1.0	---	---
Y954H62	7766-14HO x Y854 (Iso)	68	0.0	0.0	1.5	2.7	---	---
Y954H66	7766-23HO x Y854 (Iso)	69	0.0	0.0	1.4	1.7	4.4	1.6
Y954H70	7766-62HO x Y854 (Iso)	72	0.0	2.8	4.2	2.0	4.4	2.5
Y954H57	7776-1aa x Y854 (Iso)	73	0.0	1.4	4.1	2.3	4.4	3.7
Y954H58	7776-20aa x Y854 (Iso)	73	0.0	0.0	4.1	2.0	4.0	4.9
Y954H59	7776-21aa x Y854 (Iso)	72	0.0	4.2	9.7	2.0	3.9	5.1
Y954H60	7776-25aa x Y854 (Iso)	70	0.0	4.3	12.9	2.3	3.6	3.0
Y954H43	8743aa x Y854 (Iso)	72	0.0	1.4	4.2	1.7	3.6	2.5
Y954H67	8767aa (Iso) x Y854 (Iso)	71	1.4	2.8	4.2	1.7	3.5	1.7
Y954H76	8776aa (Iso) x Y854 (Iso)	68	0.0	0.0	1.5	1.0	4.0	4.2
Y954H80	8755aa x Y854 (Iso)	77	0.0	1.3	2.6	1.7	2.9	0.0
Y954H86	8787aa x Y854 (Iso)	69	0.0	2.9	8.7	2.3	4.0	3.1
Y954H90	8790aa x Y854 (Iso)	70	0.0	2.9	4.3	2.3	4.0	1.7
Y954H96	8796aa x Y854 (Iso)	74	1.4	6.8	9.5	2.0	4.6	0.9
Y954H101	8850HO x Y854 (Iso)	69	4.3	13.0	17.4	1.0	---	---
Y954H111	8851aa x Y854 (Iso)	71	0.0	4.2	4.2	1.3	4.0	4.8
Y954H113	8858aa x Y854 (Iso)	65	1.5	9.2	13.8	1.7	4.3	2.5
Y954H102	8858HO x Y854 (Iso)	65	1.5	7.7	13.8	1.7	---	---
Y954H103	8852HO x Y854 (Iso)	72	2.8	5.6	13.9	1.7	---	---
Y954H104	8857HO x Y854 (Iso)	74	0.0	1.4	2.7	1.0	---	---
Y954H115	8857aa x Y854 (Iso)	65	0.0	4.6	7.7	0.7	3.9	0.0
Y954H117	8856aa x Y854 (Iso)	67	1.5	6.0	10.4	1.3	3.8	0.8
Y954H118	8855aa x Y854 (Iso)	72	0.0	5.6	12.5	1.0	4.1	5.8
Y954H122	8863aa x Y854 (Iso)	66	1.5	9.1	16.7	1.7	4.4	3.6
Y954H105	8863HO x Y854 (Iso)	65	1.5	12.3	12.3	2.3	---	---

[1]Total number of plants over three replications for Test 490.
[2]Mean of powdery mildew ratings made 7/20/90.
[3]Powdery mildew scored on 8/13, 8/20, 8/28, and 9/4/90 where 0 = 0% leaf area infected to 9 = 90-100% covered. Mean approximately equals area under disease progress curve.
[4]% plants with downey mildew scored on 6/18 and 7/6/90.

TEST 390. BOLTING EVALUATION OF S_2 LINES FROM POPN-852 AND POPN-855, SALINAS, CA., 1990

240 entries x 2 replications
1-row plots, 16 ft. long

Planted: December 4, 1989

Variety	Description	Stand[1] Count	Bolting 6/14	Bolting 7/17	Bolting 9/6	P.M.[2] Rating
		No.	%	%	%	Avg.
4500	Inc. 1500	31	100.0	100.0	100.0	
9600(A)	Inc. 8600(A)	30	100.0	100.0	100.0	
9600(B)	Inc. 8600(B)	36	100.0	100.0	100.0	
9600HO(A)	8600HO(A) x 8600	24	100.0	100.0	100.0	
9600HO(B)	8600HO(B) x 8600	29	100.0	100.0	100.0	
7852	RZM 6224 (A,aa)	41	0.0	17.1	22.0	3.0
8852	RZM 7852 (A,aa)	41	0.0	0.0	9.8	3.0
9857	RZM 8857 (A,aa)	50	6.0	18.0	28.0	2.5
9867mm	8852,8857aa x A	47	8.5	21.3	25.5	3.0
9867H67	8767(Iso)aa x 8852,8857	41	9.8	19.5	29.3	3.0
7855	RZM 6222,3; 6208,9 (A,aa)	46	10.9	21.7	30.4	3.5
8855	RZM 7855 (A,aa)	44	2.3	9.1	11.4	3.5
9855	RZM 8855	49	4.1	2.0	4.1	2.0
9866mm	8853,5,6,aa x A	48	14.6	39.6	43.8	3.0
U486-37	C37, 86443	41	0.0	0.0	0.0	0.5
SP7622-0	L80466 (8/87)	45	80.0	95.6	95.6	2.0
9852-3-1	8852-3	40	0.0	12.5	17.5	2.5
-2	"	47	0.0	2.1	0.0	0.5
-3	"	48	2.1	2.1	6.3	4.0
-4	"	39	2.6	12.8	35.9	3.0
-5	8852-3	40	0.0	0.0	2.5	1.0
9852-4-1	8852-4	41	53.7	70.7	73.2	0.0
-2		44	0.0	2.3	4.5	2.0
-3		29	10.3	13.8	10.3	0.0
-4	8852-4	37	10.8	13.5	24.3	3.5
-5	"	42	16.7	21.4	28.6	0.0
9852-5-1	8852-5	54	3.7	14.8	24.1	4.0
-2	"	40	0.0	5.0	10.0	4.0
-3		46	0.0	2.2	2.2	3.5
-4		50	0.0	0.0	4.0	4.0
-5		54	0.0	0.0	0.0	1.5
9852-6-1	8852-6	34	5.9	11.8	14.7	4.0

TEST 390. BOLTING EVALUATION OF S_2 LINES FROM POPN-852 AND POPN-855, SALINAS, CA., 1990

(continued)

Variety	Description	Stand[1] Count	Bolting 6/14	Bolting 7/17	Bolting 9/6	P.M.[2] Rating
		No.	%	%	%	Avg.
9852-6-2	8852-6	55	0.0	0.0	0.0	4.0
-3		23	34.8	52.2	47.8	3.5
-4		32	0.0	0.0	0.0	3.0
9852-7-1	8852-7	39	0.0	0.0	0.0	3.0
-2		51	0.0	0.0	0.0	1.0
-3		45	0.0	0.0	0.0	0.5
-4		39	2.6	0.0	0.0	0.5
-5		53	0.0	0.0	1.9	1.0
9852- 7-6	8852-7	28	0.0	0.0	3.6	3.0
9852-12-1	8852-12	37	0.0	2.7	2.7	4.5
-2		37	0.0	5.4	8.1	4.5
-3		42	0.0	0.0	2.4	2.0
9852-14-1	8852-14	47	0.0	0.0	0.0	4.0
-2		40	0.0	2.5	5.0	3.0
-3		43	0.0	0.0	0.0	3.5
-4		41	0.0	0.0	0.0	6.0
-5		34	0.0	0.0	0.0	3.0
-6		37	0.0	0.0	0.0	3.0
-7		41	0.0	0.0	0.0	4.0
9852-18-1	8852-18	41	4.9	14.6	14.6	3.5
-2		40	0.0	2.5	10.0	5.5
-3		25	4.0	16.0	12.0	2.0
-4		37	0.0	0.0	2.7	4.0
9852-19-1	8852-19	49	0.0	0.0	0.0	3.0
-2		44	0.0	0.0	0.0	3.5
-3		37	0.0	0.0	0.0	3.0
-4		40	0.0	0.0	0.0	3.5
-5		45	0.0	0.0	0.0	2.0
9852-19-6	8852-19	35	0.0	0.0	0.0	3.0
9852-23-1	8852-23	45	13.3	37.8	48.9	5.0
-2		44	0.0	0.0	0.0	3.5
-3		42	33.3	40.5	33.3	1.5

TEST 390. BOLTING EVALUATION OF S_2 LINES FROM POPN-852 AND POPN-855, SALINAS, CA., 1990

(continued)

Variety	Description	Stand[1] Count	Bolting 6/14	Bolting 7/17	Bolting 9/6	P.M.[2] Rating
		No.	%	%	%	Avg.
9852-23-4	8852-23	44	0.0	15.9	20.5	5.0
-5		41	9.8	7.3	4.9	0.0
-6		37	27.0	54.1	59.5	9.0
9852-36-1	8852-36	29	65.5	69.0	69.0	3.0
-2		36	2.8	16.7	30.6	0.5
-5		42	47.6	64.3	69.0	2.0
-6		39	38.5	74.4	69.2	3.0
9852-40-1	8852-40	44	2.3	4.5	9.1	3.0
-2		46	0.0	4.3	6.5	3.0
-3		45	2.2	6.7	6.7	2.0
-4		31	3.2	25.8	25.8	3.5
9852-41-1	8852-41	40	0.0	0.0	2.5	4.0
-2		44	0.0	0.0	2.3	3.0
-3		38	0.0	2.6	2.6	5.0
-4		40	0.0	2.5	2.5	3.0
-5		45	0.0	2.2	2.2	3.0
-6		41	0.0	0.0	0.0	4.5
9852-42-1	8852-42	28	0.0	0.0	0.0	1.5
-2		30	0.0	0.0	0.0	6.0
-3		10	0.0	0.0	0.0	4.0
9852-46-1	8852-46	48	2.1	2.1	4.2	3.0
-2		50	6.0	12.0	16.0	2.0
-3		55	0.0	0.0	10.9	2.0
-4		41	0.0	0.0	0.0	3.0
-5		48	2.1	18.8	27.1	4.0
-6		37	0.0	0.0	0.0	3.5
9852-51-1	8852-51	49	16.3	36.7	36.7	6.5
-2		43	41.9	51.2	53.5	5.0
-3		40	15.0	32.5	27.5	5.5
-4		50	4.0	14.0	18.0	4.0
-5		41	7.3	14.6	19.5	3.5
-6		46	6.5	23.9	32.6	4.0

TEST 390. BOLTING EVALUATION OF S_2 LINES FROM POPN-852 AND POPN-855, SALINAS, CA., 1990

(continued)

Variety	Description	Stand[1] Count	Bolting 6/14	Bolting 7/17	Bolting 9/6	P.M.[2] Rating
		No.	%	%	%	Avg.
9852-52-1	8852-52	35	0.0	0.0	0.0	1.5
-2		43	0.0	2.3	4.7	2.0
-3		35	0.0	0.0	0.0	3.0
-4		43	0.0	0.0	0.0	2.0
-5		36	2.8	11.1	11.1	3.0
-6		40	0.0	2.5	5.0	2.0
9852-56-1	8852-56	47	0.0	2.1	4.3	0.0
-2		41	0.0	0.0	0.0	1.0
-3		38	2.6	5.3	7.9	1.0
-4		44	0.0	0.0	2.3	2.0
9852-57-1	8852-57	46	0.0	6.5	13.0	2.5
-2		49	8.2	22.4	34.7	4.5
-3		42	0.0	4.8	2.4	3.5
-4		46	0.0	8.7	10.9	3.0
-5		35	5.7	25.7	28.6	3.5
9852-62-1	8852-62	26	3.8	7.7	0.0	1.5
-2		11	0.0	0.0	9.1	3.0
-3		24	0.0	4.2	4.2	3.0
-4		15	0.0	0.0	0.0	3.5
-5		16	0.0	0.0	0.0	3.5
-6		21	4.8	9.5	9.5	2.0
9852-64-1	8852-64	45	0.0	0.0	4.4	0.5
-2		45	0.0	2.2	2.2	0.0
-3		27	7.4	18.5	18.5	1.0
-4		45	0.0	0.0	8.9	0.0
-5		52	1.9	11.5	15.4	0.0
-6		31	0.0	0.0	0.0	0.5
9852-69-1	8852-69	51	0.0	0.0	0.0	3.5
-2		41	0.0	0.0	0.0	3.0
-3		45	0.0	2.2	2.2	4.0
-4		32	0.0	3.1	6.3	1.5
9852-71-1	8852-71	43	0.0	0.0	0.0	2.0

TEST 390. BOLTING EVALUATION OF S_2 LINES FROM POPN-852 AND POPN-855, SALINAS, CA., 1990

(continued)

Variety	Description	Stand[1] Count	Bolting 6/14	Bolting 7/17	Bolting 9/6	P.M.[2] Rating
		No.	%	%	%	Avg.
9852-71-2	8852-71	46	0.0	0.0	0.0	3.5
-3		30	0.0	0.0	0.0	5.5
-4		42	0.0	0.0	0.0	
-5		33	0.0	0.0	0.0	3.5
9852-73-1	8852-73	32	18.8	28.1	34.4	3.5
-2		29	3.4	24.1	27.6	1.0
-3		37	0.0	5.4	5.4	2.0
9855-5-1	8855-5	56	0.0	0.0	1.8	3.0
-2		47	0.0	0.0	0.0	0.5
-3		49	10.2	18.4	26.5	0.5
-4		49	4.1	8.2	12.2	0.0
-5		43	14.0	25.6	27.9	3.0
-6		36	50.0	66.7	66.7	0.0
9855-8-1	8855-8	49	6.1	14.3	16.3	2.0
-2		45	15.6	51.1	66.7	3.0
-3		47	0.0	2.1	8.5	2.0
-4		28	0.0	3.6	3.6	2.5
-5		41	9.8	22.0	29.3	3.5
-6		39	7.7	15.4	28.2	3.5
9855-9-1	8855-9	37	0.0	0.0	0.0	0.0
-2		37	0.0	0.0	2.7	0.5
-3		40	0.0	0.0	0.0	0.0
-4		43	0.0	0.0	2.3	1.5
-5		39	0.0	0.0	2.6	0.5
-6		37	0.0	5.4	13.5	0.0
9855-11-1	8855-11	37	2.7	8.1	18.9	2.0
-2		39	0.0	0.0	0.0	0.0
-3		42	0.0	2.4	11.9	4.0
-4		0				
-5		32	0.0	0.0	15.6	1.5
9855-17-1	8855-17	43	0.0	0.0	4.7	4.5
-2		44	0.0	0.0	0.0	4.5

TEST 390. BOLTING EVALUATION OF S_2 LINES FROM POPN-852 AND POPN-855, SALINAS, CA., 1990

(continued)

Variety	Description	Stand[1] Count	Bolting 6/14	Bolting 7/17	Bolting 9/6	P.M.[2] Rating
		No.	%	%	%	Avg.
9855-17-3	8855-17	48	0.0	0.0	2.1	6.0
-4		42	0.0	0.0	4.8	5.5
-5		35	0.0	0.0	5.7	8.5
-6		42	7.1	26.2	38.1	7.5
9855-18-1	8855-18	51	0.0	0.0	3.9	3.0
-2		36	0.0	11.1	13.9	2.0
-3		47	0.0	14.9	25.5	2.5
-4		50	0.0	0.0	4.0	2.5
-5		0				
9855-21-1	8855-21	39	0.0	2.6	2.6	3.5
-2		44	0.0	0.0	0.0	4.0
-3		36	0.0	0.0	0.0	4.0
-4		31	0.0	9.7	6.5	0.5
-5		35	0.0	2.9	2.9	2.0
-6		37	0.0	0.0	0.0	3.0
9855-22-1	8855-22	45	0.0	0.0	0.0	1.0
-2		42	2.4	7.1	14.3	2.0
-3		43	0.0	0.0	4.7	2.5
-4		35	0.0	0.0	2.9	2.5
-5		46	0.0	4.3	15.2	2.0
9855-23-1	8855-23	30	26.7	43.3	56.7	2.0
-2		49	0.0	4.1	4.1	2.0
-3		46	2.2	21.7	28.3	3.5
-4		51	5.9	17.6	31.4	4.5
-5		48	6.3	6.3	8.3	1.0
9855-24-1	8855-24	49	8.2	12.2	24.5	0.0
-2		44	0.0	2.3	2.3	0.5
-3		44	0.0	0.0	0.0	0.0
-4		48	0.0	0.0	0.0	0.0
-5		48	0.0	0.0	2.1	0.0
9855-28-1	8855-28	44	4.5	20.5	31.8	2.0
-2		42	54.8	69.0	61.9	1.5

TEST 390. BOLTING EVALUATION OF S_2 LINES FROM POPN-852 AND POPN-855, SALINAS, CA., 1990

(continued)

Variety	Description	Stand[1] Count	Bolting 6/14	Bolting 7/17	Bolting 9/6	P.M.[2] Rating
		No.	%	%	%	Avg.
9855-28-3	8855-28	48	2.1	14.6	27.1	1.5
-4		50	2.0	8.0	12.0	2.5
9855-35-1	8855-35	44	0.0	4.5	9.1	4.0
-2		43	16.3	25.6	30.2	4.5
-3		25	0.0	0.0	0.0	4.0
-4		47	29.8	61.7	68.1	4.5
-6		37	0.0	8.1	10.8	5.0
9855-38-1	8855-38	34	2.9	2.9	11.8	4.5
9855-38-2	8855-38	29	0.0	0.0	0.0	4.0
-3		28	0.0	3.6	3.6	3.5
-4		25	4.0	8.0	8.0	3.5
-5		21	0.0	14.3	9.5	3.5
9855-41-1	8855-41	50	30.0	58.0	66.0	3.5
-2		46	43.5	71.7	71.7	4.5
-3		53	9.4	24.5	24.5	4.5
-4		43	9.3	30.2	27.9	1.0
-5		53	56.6	67.9	81.1	4.5
-6		49	83.7	100.0	100.0	6.0
9855-44-1	8855-44	52	32.7	63.5	59.6	7.0
-2		46	4.3	17.4	30.4	5.5
-3		45	4.4	20.0	31.1	5.5
-4		49	61.2	91.8	93.9	6.0
9855-48-1	8855-48	47	0.0	0.0	2.1	2.5
-2		30	3.3	10.0	10.0	1.5
-3		19	0.0	0.0	0.0	3.5
-4		36	0.0	5.6	13.9	3.5
9855-54-1	8855-54	34	23.5	44.1	47.1	3.0
-2		45	73.3	80.0	62.2	0.5
9855-54-3	8855-54	51	17.6	21.6	23.5	1.5
-4		47	63.8	85.1	91.5	1.5
-5		38	15.8	28.9	36.8	2.0
9855-56-1	8855-56	35	0.0	2.9	2.9	2.0

TEST 390. BOLTING EVALUATION OF S_2 LINES FROM POPN-852 AND POPN-855, SALINAS, CA., 1990

(continued)

Variety	Description	Stand[1] Count	Bolting 6/14	Bolting 7/17	Bolting 9/6	P.M.[2] Rating
		No.	%	%	%	Avg.
9855-56-2	8855-56	41	0.0	2.4	0.0	2.5
-3		42	0.0	0.0	2.4	1.5
-4		43	0.0	4.7	4.7	2.0
-5		41	7.3	9.8	9.8	2.0
-6		43	0.0	0.0	2.3	2.0
9855-59-1	9855-59	48	0.0	0.0	0.0	0.5
-2		39	0.0	5.1	10.3	0.5
-3		39	0.0	0.0	0.0	2.0
-4		27	0.0	0.0	0.0	1.0
9855-62-1	9855-62	44	72.7	93.2	95.5	7.0
-2		41	2.4	48.8	65.9	4.5
-3		45	26.7	60.0	62.2	5.0
-4		44	0.0	27.3	43.2	5.0
-5		47	87.2	100.0	97.9	7.0
-6		46	34.8	73.9	87.0	4.5
F82-562HO	(82195)	40	7.5	30.0	40.0	2.0

TEST 2690. CODED POWDERY MILDEW TEST:
EVALUATION OF TEST AND MARKET HYBRIDS, SALINAS, CA, 1990

Planted: April 18, 1990
120 entries x 5 replications
1-row plots, 16 ft. long, 20 rows wide

Entry No.	Variety	Co.[3]	No. Plants[1]	Powdery Mildew Rating[2] 8/13	8/20	8/28	9/4	Mean	Downey Mildew %[4] 6/11	7/2
90-PM- 1	7BG6164	B	113	3.4	4.4	5.6	6.4	4.9	3.5	6.5
- 2	HH-51	HS	118	2.4	4.0	4.6	4.8	4.0	0.8	3.3
- 3	HM 3007	H	111	2.4	3.6	4.6	5.2	4.0	2.3	4.7
- 4	HH-70	HS	115	3.6	5.2	6.6	7.6	5.8	0.0	2.8
- 5	85C 62-016	HS	114	3.4	4.6	5.2	5.2	4.6	0.0	1.9
- 6	7BG6092	B	103	1.4	3.4	4.6	5.0	3.6	0.0	2.9
- 7	SS-181	SS	109	3.0	4.4	5.0	6.2	4.7	0.0	1.9
- 8	8BC6391	B	103	3.4	4.8	5.8	6.8	5.2	1.1	2.1
- 9	SS-Y1	SS	103	3.2	3.8	5.0	6.4	4.6	1.0	2.0
- 10	6BG6151	B	112	4.2	6.0	7.8	8.2	6.6	0.0	2.7
- 11	H84377	SS	100	2.8	4.4	5.2	6.6	4.8	0.0	2.2
- 12	H87497	SS	109	3.4	4.2	5.6	7.2	5.1	0.8	4.7
- 13	HH-52	HS	111	2.6	3.8	4.4	5.6	4.1	3.4	5.2
- 14	SS-334	SS	114	2.8	4.0	4.8	6.0	4.4	0.0	8.0
- 15	86-1459-026	HS	111	3.4	4.6	5.2	5.8	4.8	1.9	2.9
- 16	HH-46	HS	113	3.2	4.2	4.8	5.6	4.4	0.0	5.5
- 17	84C 39-024	HS	109	3.2	4.4	5.0	6.0	4.7	1.0	1.8
- 18	H85231	SS	107	3.2	4.0	5.0	6.2	4.6	3.9	6.8
- 19	USH-11	Susc.ck.	112	4.2	5.2	6.2	7.2	5.7	4.7	5.6
- 20	SS-270	SS	115	3.6	4.8	5.4	6.8	5.2	3.0	3.0
- 21	SS-22	SS	107	3.2	4.2	4.8	5.8	4.5	2.2	5.8
- 22	H87420	SS	109	3.2	4.6	5.0	5.4	4.6	2.1	2.1
- 23	H86502	SS	108	3.4	4.4	5.2	6.4	4.8	4.4	8.9
- 24	HM 3009	H	109	3.4	4.2	5.0	6.8	4.8	0.9	2.5

TEST 2690. CODED POWDERY MILDEW TEST:
EVALUATION OF TEST AND MARKET HYBRIDS, SALINAS, CA, 1990

(continued)

Entry No.	Variety	Co.[3]	No. Plants[1]	Powdery Mildew Rating[2] 8/13	8/20	8/28	9/4	Mean	Downey Mildew %[4] 6/11	7/2
- 25	SS-165	SS	103	3.6	4.8	5.8	6.2	5.1	0.0	2.8
- 26	8BG6332	B	113	4.0	5.2	6.4	7.0	5.7	1.7	1.7
- 27	86-84C65-05	HS	103	4.2	5.0	5.8	6.4	5.3	4.2	10.2
- 28	HH-66	HS	107	4.4	5.6	6.6	7.6	6.1	1.4	5.4
- 29	HM 3006	H	105	3.4	4.4	5.4	6.8	5.0	2.8	2.8
- 30	HM 3011	H	102	2.8	4.0	4.8	6.0	4.4	3.6	4.7
- 31	H85211	SS	109	3.8	4.8	5.6	6.6	5.2	3.5	5.5
- 32	H88199	SS	99	1.4	2.4	2.8	3.0	2.4	1.1	6.9
- 33	HH-79	HS	106	4.4	5.8	6.4	6.8	5.8	3.8	4.8
- 34	8BG6262	B	111	1.0	1.8	3.2	4.0	2.5	1.8	4.9
- 35	HH-38	HS	121	2.2	2.6	3.8	5.2	3.5	0.0	0.8
- 36	H86246	SS	114	2.8	4.2	5.2	6.4	4.7	2.7	6.5
- 37	H87245	SS	99	2.6	3.8	5.0	5.8	4.3	2.0	5.9
- 38	H86460	SS	111	2.8	3.8	4.8	5.6	4.3	0.9	3.8
- 39	87C 40-011	HS	102	4.0	5.2	6.2	6.8	5.6	3.9	13.0
- 40	HH-41	HS	106	3.2	4.2	4.8	5.2	4.3	2.8	2.8
- 41	HM 3005	H	108	3.2	4.0	5.4	6.4	4.8	2.7	3.4
- 42	8BG6132	B	114	4.4	6.0	7.0	7.2	6.2	0.8	2.7
- 43	86-84C80-05	HS	91	3.0	4.2	4.8	5.6	4.4	0.0	1.1
- 44	7BG6183	B	113	4.0	4.8	5.8	7.2	5.4	1.8	2.8
- 45	86-84C36-012	HS	109	3.4	4.8	5.4	6.6	5.1	1.9	1.9
- 46	9BG6372	B	107	2.2	3.6	4.4	4.8	3.8	0.9	7.2
- 47	HH-77	HS	106	3.4	4.2	5.4	6.2	4.8	1.0	6.6
- 48	HM 3010	H	114	2.6	3.8	4.6	6.0	4.3	1.7	2.6

TEST 2690. CODED POWDERY MILDEW TEST:
EVALUATION OF TEST AND MARKET HYBRIDS, SALINAS, CA, 1990

(continued)

(continued)

Entry No.	Variety	Co.[3]	No. Plants[1]	Powdery Mildew Rating[2] 8/13	8/20	8/28	9/4	Mean	Downey Mildew %[4] 6/11	7/2
PM-90- 49	89C 58-03	HS	118	3.4	5.0	6.2	7.6	5.6	0.0	0.8
- 50	6BG6209	B	106	1.8	3.2	4.0	5.0	3.5	2.0	7.5
- 51	USC-4	HS	114	3.2	4.4	5.2	6.2	4.8	0.8	4.9
- 52	H87545	SS	119	3.2	4.8	5.6	6.8	5.1	4.9	5.9
- 53	Hill 2	H	104	2.6	3.4	4.4	5.4	4.0	1.1	5.0
- 54	84C 39-015	HS	111	2.4	4.0	4.6	6.2	4.3	2.6	5.6
- 55	USC-1	HS	108	3.0	4.2	5.0	6.6	4.7	1.9	1.9
- 56	SS-21	SS	93	3.6	4.8	5.8	6.4	5.2	2.7	5.0
- 57	H86466	SS	118	3.4	4.2	5.4	6.4	4.8	3.5	9.4
- 58	H87277	SS	110	2.8	4.0	4.6	5.2	4.2	4.0	4.0
- 59	86C 148-04	HS	115	3.0	4.6	5.6	6.6	4.9	2.0	2.8
- 60	HM 3012	H	112	3.6	5.4	6.0	6.2	5.3	1.7	4.5
- 61	HH-54	HS	116	3.6	4.4	5.2	6.4	4.9	0.8	0.8
- 62	84C 39-027	HS	108	3.6	4.2	5.2	6.0	4.8	0.8	8.4
- 63	H86519	SS	117	4.0	5.4	7.0	6.8	5.8	0.0	0.8
- 64	HH-55	HS	115	2.4	3.2	3.2	4.0	3.2	0.9	3.4
- 65	89C 58-07	HS	105	4.0	5.8	7.0	7.4	6.1	2.0	0.9
- 66	87-1459-080	HS	107	2.4	4.6	5.6	6.6	4.8	0.0	2.7
- 67	SS-NB2	SS	117	2.8	4.0	5.0	6.0	4.4	0.0	1.0
- 68	HM 6036	H	107	3.2	4.4	5.4	6.2	4.8	3.4	3.4
- 69	H86558	SS	111	1.6	3.4	4.0	4.6	3.4	1.0	5.6
- 70	7BG6088	B	106	0.8	2.0	3.8	4.2	2.7	1.1	4.9
- 71	7BG6103	B	106	1.2	2.8	4.0	4.4	3.1	2.8	4.8
- 72	Rhizosen	HS	106	3.0	4.6	5.0	5.6	4.6	0.0	5.4

TEST 2690. CODED POWDERY MILDEW TEST:
EVALUATION OF TEST AND MARKET HYBRIDS, SALINAS, CA, 1990

(continued)

Entry No.	Variety	Co.[3]	No. Plants[1]	Powdery Mildew Rating[2] 8/13	8/20	8/28	9/4	Mean	Downey Mildew %[4] 6/11	7/2
PM-90- 73	4581	B	113	2.8	3.8	4.4	5.0	4.0	1.1	5.1
- 74	84C 39-033	HS	113	3.2	4.0	5.0	5.6	4.4	1.0	1.9
- 75	86C 15-014	HS	120	3.6	4.2	5.6	6.4	4.9	1.8	1.8
- 76	H88289	SS	115	3.8	4.2	5.0	6.2	4.8	1.9	4.4
- 77	87C 40-012	HS	113	5.8	7.2	8.0	7.4	7.1	0.0	1.8
- 78	USC-5	HS	110	3.6	5.4	6.0	6.8	5.4	4.0	5.7
- 79	4654	B	119	3.0	4.0	4.8	5.6	4.3	0.9	2.7
- 80	SS-LS2	SS	107	2.6	4.0	5.6	6.4	4.7	2.0	4.7
- 81	6BG6207	B	116	2.0	2.6	4.0	4.6	3.3	2.7	3.7
- 82	8BG6155	B	112	1.6	2.6	4.0	4.2	3.1	1.7	1.8
- 83	USH-11	Susc.ck.	103	4.2	5.6	6.6	7.0	5.8	0.9	3.7
- 84	8BC6384	B	105	2.8	4.2	5.0	5.6	4.4	2.0	4.7
- 85	86-84C65-06	HS	106	3.4	4.6	5.4	6.2	4.9	1.9	3.8
- 86	87C 40-08	HS	109	3.8	5.4	6.2	7.6	5.8	1.7	6.8
- 87	4625	B	117	3.0	3.8	5.2	6.2	4.6	0.8	3.4
- 88	86-84C25-013	HS	101	3.0	4.2	4.6	5.6	4.3	1.1	4.2
- 89	8BG6152	B	120	1.4	2.8	3.0	4.6	3.0	3.5	5.3
- 90	Hill 1	H	106	2.2	3.2	4.2	5.4	3.8	1.0	3.1
- 91	8BG6143	B	116	2.8	3.6	4.4	5.4	4.1	0.0	3.5
- 92	USH-11	Susc.ck.	112	3.8	5.6	6.0	6.6	5.5	1.0	2.7
- 93	8BG6169	B	114	3.0	3.8	4.6	5.8	4.3	1.8	2.6
- 94	4757	B	105	1.4	3.0	2.8	3.6	2.7	0.0	1.1
- 95	HM 6027	H	113	3.0	4.0	4.0	5.2	4.1	0.0	0.9
- 96	6BG6165	B	105	3.0	3.8	4.4	5.4	4.2	0.9	1.2

TEST 2690. CODED POWDERY MILDEW TEST:
EVALUATION OF TEST AND MARKET HYBRIDS, SALINAS, CA, 1990

(continued)

Entry No.	Variety	Co.[3]	No. Plants[1]	Powdery Mildew Rating[2] 8/13	8/20	8/28	9/4	Mean	Downey Mildew %[4] 6/11	7/2
PM-90- 97	87C 144-04	HS	116	3.4	4.8	5.2	6.2	4.9	0.8	3.2
- 98	SS-334R	SS	94	4.6	5.8	7.2	7.6	6.3	1.1	5.1
- 99	HH-37	HS	111	3.6	4.8	5.8	6.6	5.2	2.0	5.2
-100	86-84C25-020	HS	113	3.8	4.8	6.2	7.0	5.4	0.0	3.4
-101	USH-11	Susc.ck.	103	3.8	5.2	6.2	6.6	5.4	0.0	2.9
-102	H87316	SS	105	3.6	4.6	5.8	6.6	5.2	0.0	5.5
-103	HM 5330	H	104	2.4	3.4	3.6	4.6	3.5	0.0	3.0
-104	HH-69	HS	111	2.8	4.2	4.6	5.6	4.3	0.8	1.0
-105	4480	B	104	2.0	3.6	4.2	5.2	3.8	0.0	1.9
-106	84C 39-029	HS	107	3.2	4.2	5.4	6.4	4.8	1.0	4.8
-107	HH-80	HS	100	4.6	6.2	7.2	8.0	6.5	2.1	9.2
-108	HH-45	HS	113	2.6	3.8	4.6	5.4	4.1	1.0	2.0
-109	H88242	SS	113	3.4	5.0	6.2	6.2	5.2	0.9	0.9
-110	88-1459-049	HS	110	3.0	5.2	6.2	7.4	5.4	0.8	1.7
-111	SS-NB3	SS	105	3.4	4.6	5.8	6.8	5.2	0.0	2.4
-112	4587	B	109	2.2	3.6	5.2	5.8	4.2	3.4	3.4
US H11			109	3.4	5.2	6.0	6.0	5.2	0.9	1.9
US H11			107	4.2	5.6	6.2	6.4	5.6	1.0	2.6
F86-91			101	1.8	2.0	3.0	3.0	2.5	0.0	0.0
F86-91			98	1.0	2.6	3.4	4.2	2.8	1.3	10.3
F86-91			95	1.4	2.8	3.8	5.2	3.3	1.3	3.1
F86-91			95	2.2	3.4	3.8	4.0	3.3	1.1	6.6
F86-91			95	2.0	2.6	3.8	5.0	3.3	1.1	4.2
F86-91			99	2.2	3.0	3.8	4.2	3.3	5.8	7.6

TEST 2690. CODED POWDERY MILDEW TEST:
EVALUATION OF TEST AND MARKET HYBRIDS, SALINAS, CA, 1990

[1] Total number of plants over five replications.

[2] Powdery mildew scored on 8/13, 8/20, 8/28, and 9/4/90 where 0 = 0% leaf area infected to 9 = 90-100% covered. Mean approximately equals area under disease progress curve.

[3] Company designation: H = Hilleshog, B = Betaseed, HS = Holly, and SS = Spreckels.

[4] % plants with Downey mildew scored on 6/11, and 7/2/90.

CURLY TOP EVALUATION OF SALINAS ENTRIES AT KIMBERLY, IDAHO, 1990
150 entries x 3 replications
Test Conducted by Terry Brown, BSDF

Variety	Description	CT Grade[1] 1st Rating	CT Grade[1] 2nd Rating
CHECKS			
US 33		5.1*	5.7*
US 41		4.3*	4.9*
HYBRIDS			
US H11	546H3 x C36	4.0	4.7
HH 46	Holly (L46304)	4.0	4.7
Rhizosen	Holly	6.5	7.0
4581	Betaseed (2/21/90)	6.7	7.0
HH54	Holly (12/11/89)	6.0	6.3
9101H8	(C562HO x C546) x C11T	7.7	8.0
9102H8	(C562HO x C546) x C12T	6.5	7.0
Y954H20	(C562HO x C309) x C54	4.3	5.3
Y846H20	(C562HO x C309) x C46/3	4.3	5.0
Y931H20	(C562HO x C309) x C31/6	4.7	5.0
Y931H39	C762-17HO x C31/6	4.7	5.3
Y949H20	(C562HO x C309) x C49	5.0	5.3
R939/4H20	(C562HO x C309) x C39R4	5.0	5.0
R970H20	(C562HO x C309) x R871-80	5.0	5.0
9910H20	(C562HO x C309) x 8910	4.3	4.7
9911H20	(C562HO x C309) x 8911	4.0	4.7
9912H20	(C562HO x C309) x 8908-11	4.0	5.0
Y954H3	C562HO x C54	4.0	4.7
Y954H8	(C562HO x C546) x C54	4.3	4.3
Y954H18	(C309CMS x C790-68) x C54	4.0	5.0
Y954H23	(C306CMS x C309) x C54)	4.0	4.7
Y954H38	C312CMS x C54	4.0	5.0
Y954H40	C313CMS x C54	4.3	4.7
Y954H39	C762-17CMS x C54	3.7	4.0
Y954H50	8767-20HO x C54	5.0	5.7
Y954H52	8767-30HO x C54	4.7	5.0
Y954H54	C767-46CMS x C54	4.7	5.3
Y954H66	C766-23CMS x C54	4.3	5.7
Y954H70	C766-62CMS x C54	4.3	4.7
Y954H72	C718HO x C54	4.0	4.7
Y954H89	C790-68CMS x C54	4.7	5.0
Y954H92	C796-22CMS x C54	4.0	4.3
Y954H67	8767aa x C54	4.7	5.0
Y954H113	8858aa x C54	4.3	5.0
Y954H115	8857aa x C54	5.3	5.7
Y954H117	8856aa x C54	5.7	5.7
Y954H118	8855aa x C54	5.0	5.7
Y954H122	8863aa x C54	5.3	5.7
SS-NB3	Spreckels	4.7	5.0
US H11	546H3 x C36	4.7	5.0
MM, OPEN-POLLINATED			
Y009	Inc. US22/3	4.7	5.0
768	Inc. 868 (US 75)	4.3	5.0
U86-37	Inc. C37 (86443)	4.7	5.0
R974	RZM R874	5.0	5.7
R979	Inc. R879 ($C37R_z$)	4.3	5.7
R928C1	RZM F_1(C37 x PI07)	5.0	5.7
R929C1	RZM F_1(5747aa x PI07)	6.0	7.3
9101	Inc. C11T	7.3	8.3
9102	Inc. C12T	7.7	8.0
U86-46/2	Inc. C46/2 (86342)	5.7	5.3
R973	RZM R873	6.0	6.3
R978C2	RZM R878 ($C46/2R_z$)	6.0	5.7
F86-31/6	Inc. C31/6 (86263)	6.7	7.0
Y931	Inc. Y731 (YRS)	6.7	7.0
Y931D	Inc. Y731 (Davis)	5.7	6.3
Y931S	Inc. Y731 (Salinas)	6.3	6.7

[1] Mean of 3 replications

* = average of 22 to 26 times repeated in test

CURLY TOP EVALUATION OF SALINAS ENTRIES AT KIMBERLY, IDAHO, 1990
(continued)

Variety	Description	CT Grade[1] 1st Rating	CT Grade[1] 2nd Rating
MM, OPEN-POLLINATED			
R971	RZM R871	6.0	6.0
R976	RZM R876 (C31/6R_z)	6.3	6.7
Y931/10	Inc. Y731-10	7.0	7.3
Y931-43	Inc. Y731-43	7.0	7.0
Y931-71	Inc. Y731-71	6.7	7.3
Y931-75	Inc. Y731-75	6.7	7.0
Y931-89	Inc. Y731-89	7.0	7.0
Y931-94	Inc. Y731-94	6.0	6.5
Y954	Inc Y854 (C54)	6.5	6.5
R975	Inc. R875	4.5	5.5
R980	RZM 8244 (C54R_z)	5.0	5.5
R977	RZM R877 (C92R_z)	5.7	6.3
R970	RZM R871-R880	5.3	6.0
Y939	YR-ER-PMR Y739 (C39)	4.7	5.3
R939C5	RZM R839C4 (C39R5)	5.3	5.7
Y947	YR-ER-PMR Y747 (C47)	5.3	5.3
R974C5	RZM R847C4 (C47R5)	6.3	6.7
R903	RZM R803 (Alba)	6.7	7.3
R904	RZM Italian	5.3	6.0
R920	RZM R820 (C94)	6.3	7.3
Y941	YR-ER-PMR Y741 (C91)	5.7	6.3
Y948	YR-ER-PMR Y748 (C93)	5.3	6.0
Y949	Inc. Y849 (C49)	5.7	6.0
Y956	YR-ER-PMR Y756,Y656	5.0	6.3
R722	Inc. F_2 (Y54 x B.m.)	5.0	6.3
R922R	RZM R722	6.3	7.0
R922Y	BYR R722	6.0	6.0
R921	RZM (C37*2 x WB41, 42)	4.7	5.7
R924	RZM (C37*3 x WB41)	4.7	5.3
R925	RZM (C37*3 x WB42)	4.0	5.0
U86-37	Inc. C37 (86443)	4.3	5.0
Y954	Inc. Y854 (C54)	5.3	6.0

Variety	Description	CT Grade 1st Rating	CT Grade 2nd Rating
MM, S^f, A:aa POPULATIONS			
R939/4H44	8904aa x R839C4	5.3	6.3
5747	4747aa x A	5.3	5.3
9910	RZM 8910 (A,aa)	4.7	5.7
9910	8910aa x A	4.3	5.0
9910H47	5747aa x 8910	4.0	5.0
9903	YR-ER-PMR 7903 (A,aa)	4.3	4.7
9911	RZM 8911 (A,aa)	4.3	5.3
9911	8911aa x A	4.7	5.3
9911H49	7903aa x 8911	4.3	5.0
9912	RZM 8909,9,10,11aa x A	5.0	5.3
9907-14	Inc. 7907-14-# (S_1)	6.3	7.0
9907-21	Inc. 7907-21-# (S_1)	5.7	6.0
9908-2	Inc. 8908-2-# (FS)	6.0	6.5
9908-7	Inc. 7908-7-# (FS)	6.0	7.0
9909-13	Inc. 8909-13-# (FS)	4.7	5.7
9909-14	Inc. 8909-14-# (FS)	4.3	5.7
9909-16	Inc. 8909-16-# (FS)	4.3	5.3
9905	YR-ER-PMR 7905 (A,aa)	4.0	5.0
mm, S^f, A:aa POPULATIONS			
8755	(C310), 7755,6aa x A	4.3	5.0
9855	RZM 8855	4.7	5.0
9856	RZM 8856 (C310R_z)	4.7	5.3
9865	RZM 8246 (C309R_z)	5.7	7.0
9866m	8853,5,6aa x A	5.7	6.3
9866H80	8755aa x 8853,5,6	5.7	6.0
8767	NB 6767 (A,aa)	5.3	6.0
9852	RZM 8852	5.3	6.0
9857	RZM 8857	4.3	5.3
9864	RZM 8247 (767R_z)	5.3	5.3
9867m	8852,7aa x A	5.0	5.3
9867H67	8767aa x 8852,7	4.7	5.0
8776	NB 6776 (A,aa)	5.0	5.3
9863	RZM 8863 (776R_z)	4.7	5.0

CURLY TOP EVALUATION OF SALINAS ENTRIES AT KIMBERLY, IDAHO, 1990
(continued)

Variety	Description	CT Grade[1] 1st Rating	CT Grade[1] 2nd Rating
mm, S_f, A:aa POPULATIONS			
9876m	8860,1,2,3,aa x A	5.3	5.3
9876H76	8776aa x 8860,1,2,3	4.7	5.3
9887m	RZM 8850,...8863	4.7	5.0
9887H86	8787aa x RZM 8850-63	4.7	5.0
9776-1	Inc. 7776-1 (HS)	4.3	5.0
9776-20	Inc. 7776-20 (HS)	4.3	5.0
9776-21	Inc. 7776-21 (HS)	5.0	5.0
9776-25	Inc. 7776-25 (HS)	5.7	5.0
mm, S_f LINES			
F82-546H3	C562HO x C546 (82460)	4.0	5.0
9554H1	NB1CMS x NB4	4.7	5.0
9851	RZM 8851	5.7	6.0
9858	RZM 8858 ($C563R_z$)	5.0	5.7
9859m	8850,51,54,58aa x A	4.7	5.0
9859H6	C566aa x 8850-58	4.0	4.7
88-790-68	Inc. C790-68	6.0	6.3
88-790-68H92	C796-22CMS x C790-68	4.0	4.7
87-309H3	(87671)C562HO x C309	4.3	5.0
87-309H37	(87242) C306CMS x C309	4.7	5.0
87-309	(87672) Inc. C309	5.3	6.0
9807	Inc. T-O C306	5.7	5.7
9833	Inc. T-O (C303aa x C309)	5.3	5.7
89-312	Inc. C312	5.7	6.7
89-313	Inc. C313	6.3	6.3
89-762-17	Inc. C762-17	3.7	3.7
F82-562	Inc. C562 (82196)	4.0	4.3
9767-46	Inc. 8767-46 (C767-46)	5.7	6.0
8767-20	Inc. 5767-20	5.3	6.0
8767-30	Inc. 5767-30	5.7	5.7
9766-23	Inc. C766-23	6.7	7.3
9766-62	Inc. C766-62	6.3	6.0

TEST RZM 190-1. 1990 EVALUATION OF AMES PI #'s FOR VIRUS YELLOWS AND RHIZOMANIA
SALINAS, CA., 1990

64 entries[8] x 3 reps, RCB
1-row plots, 10 ft., long

Planted: May 16, 1990
Natural infection to BWYV
Harvested: November 26, 1990

P.I.# Variety	Source	Harv. Count	#1 End Use[1]	#5 Pop. Unif.[2]	#12 Mature Leaf Blade Pigment[3]	#19 Petiole Color[4]	#37 Bolting Tend.[5]	#61 BWYV[6] 8/22	#61 BWYV[6] 9/25	#74 Rhizomania[7] Score
Ames 4189	Netherlands	63	8	2	3	4	3	4.7	4.0	7
Ames 4190	Italy	57	8	2	3	4	3	3.7	5.3	7
Ames 4195	Netherlands	63	7	1	3	4	2	3.0	4.3	5
Ames 4196	Netherlands	23	8	1	3	4	3	6.0	---	7
Ames 4197	Unknown	66	8	1	3	4	3	3.7	4.5	7
Ames 4198	Netherlands	73	8	1	3	4	3	2.7	---	7
Ames 4199	Unknown	38	8	1	3	4	1	5.0	---	7
Ames 4200	Netherlands	78	8	2	2	4	3	3.3	4.0	7
Ames 4201	Turkey	61	8	2	3	4	3	4.0	4.0	7
Ames 4205	Unknown	30	8	1	3	4	1	---	---	7
Ames 4207	Italy	58	8	2	3	4	3	3.0	---	7
Ames 4212	United Kingdom	67	7	2	3	4	2	2.0	3.7	7
Ames 4214	United Kingdom	59	5	1	3	4	2	1.7	3.3	5
Ames 4215	Unknown	66	5	1	2	4	2	1.7	5.3	5
Ames 4217	United Kingdom	71	5	1	3	4	2	1.3	2.7	5
Ames 4218	United Kingdom	70	3	1	2	4	2	1.3	3.0	5
Ames 4221	France	66	1	1	3	4	2	3.0	5.7	7
Ames 4222	Greece	35	8	2	3	4	3	3.3	---	7
Ames 4223	Greece	41	8	1	3	4	3	3.0	---	7
Ames 4225	Greece	47	8	2	3	4	3	3.7	7.0	7
Ames 4226	Greece	49	8	2	3	4	3	3.0	5.0	7
Ames 4228	Greece	47	8	2	3	4	3	3.7	4.5	7
Ames 4229	Greece	51	8	2	3	4	3	4.3	6.5	7
Ames 4232	Greece	56	8	2	3	4	3	4.3	6.0	9
Ames 4233	Greece	67	8	2	2	4	3	3.7	5.0	7

TEST RZM 190-1. 1990 EVALUATION OF AMES PI #'s FOR VIRUS YELLOWS AND RHIZOMANIA
SALINAS, CA., 1990

continued

P.I.# Variety	Source	Harv. Count	#1 End Use[1]	#5 Pop. Unif.[2]	#12 Mature Leaf Blade Pigment[3]	#19 Petiole Color[4]	#37 Bolting Tend.[5]	#61 BWYV[6] 8/22	#61 BWYV[6] 9/25	#74 Rhizomania[7] Score
Ames 4234	Greece	50	8	2	2	4	3	4.7	---	7
Ames 4235	Turkey	50	8	1	3	4	1	5.0	---	7
Ames 4239	Greece	59	8	2	3	4	3	4.7	5.0	7
Ames 4243	France	46	1	1	2	4	2	2.0	5.7	5
Ames 4244	Netherlands	52	8	2	3	4	3	4.0	6.7	7
Ames 4245	Netherlands	46	1	2	3	4	2	4.0	5.0	9
Ames 4246	Uncertain	53	1	2	3	4	2	3.0	6.0	7
Ames 4247	France	61	8	2	3	4	3	4.0	7.5	7
Ames 4248	Denmark	65	5	2	3	4	2	3.3	4.7	5
Ames 4249	Ireland	68	3	2	2	1	2	2.0	3.7	5
Ames 4250	Unknown	85	5	1	2	1	2	1.7	3.3	5
Ames 4251	United Kingdom	88	5	1	3	4	2	1.0	1.7	5
Ames 4252	Netherlands	49	8	1	2	1	1	1.7	3.0	7
Ames 4253	Greece	61	8	2	3	4	3	4.0	4.3	7
Ames 4254	Italy	59	8	2	3	4	3	2.3	3.5	5
Ames 4255	Italy	69	8	2	3	4	3	2.3	5.0	7
Ames 4256	Greece	44	8	1	3	4	1	5.5	---	7
Ames 4257	Greece	44	8	1	3	4	1	5.0	---	7
Ames 4258	Greece	76	8	2	3	4	3	4.7	5.0	7
Ames 4259	India	72	8	1	3	4	1	4.3	---	7
Ames 4260	Turkey	49	8	1	3	4	1	5.0	---	7
Ames 4261	Greece	48	8	1	3	4	1	4.7	---	7
Ames 8285	Unknown	57	8	3	3	4	3	3.7	4.0	7
Ames 8286	Unknown	64	8	2	2	4	3	3.3	7.0	7
Ames 8287	Unknown	51	8	3	3	4	3	4.0	4.0	7

TEST RZM 190-1. 1990 EVALUATION OF AMES PI #'s FOR VIRUS YELLOWS AND RHIZOMANIA
SALINAS, CA., 1990

continued

P.I.# Variety	Source	Harv. Count	#1 End Use[1]	#5 Pop. Unif.[2]	#12 Mature Leaf Blade Pigment[3]	#19 Petiole Color[4]	#37 Bolting Tend.[5]	#61 BWYV[6] 8/22	#61 BWYV[6] 9/25	#74 Rhizomania[7] Score
Ames 8288	Unknown	50	3	3	3	4	2	3.3	6.3	9
Ames 8289	Unknown	65	1	1	2	1	2	2.0	6.3	7
Ames 8294	Unknown	42	1	1	2	1	2	3.3	5.7	7
Ames 8295	Unknown	64	3	3	3	4	2	2.7	5.7	7
Ames 8297	Unknown	57	8	2	3	4	3	4.7	5.0	7
Ames 8298	Unknown	51	8	3	3	4	3	4.7	4.5	7
Ames 8302	Unknown	65	5	1	2	1	2	2.3	5.3	7
Checks										
US H11	L786442	69	5	1	2	1	2	2.3	6.3	7
R939/4	Inc. R839(C4)	61	5	1	2	1	2	0.7	3.6	3
R921	RZM R821	86	5	1	2	1	2	1.0	4.0	3
R922R	RZM R722	87	8	2	2	4	3	1.3	4.7	5
R928C1	RZM S228	83	5	2	2	4	2	1.3	5.6	5
R971	RZM R871	79	5	1	2	4	2	1.0	4.3	5
SP7622-0	L80466	84	1	1	2	4	2	2.7	7.0	7

TEST RZM 190-1. 1990 EVALUATION OF AMES PI #'s FOR VIRUS YELLOWS AND RHIZOMANIA
SALINAS, CA., 1990

continued

[1] #1 End use based upon field plot appearance where: 1=chard; 2=DDR-like; 3=DDR, chard, spinach; 4=fodder; 5=sugar; 7=mixed, 8=annual.

[2] #5 Population Uniformity: 1=all plants alike; 2=uneven different types; 3=mixed, green, red, yellow, high, low, large leaves, small leaves, etc.

[3] #12 Mature Leaf Blade Pigmentation: 1=light green (chard), 2=green, 3=red & green, 4=red, 5=yellow.

[4] #19 Petiole Color: 1=green, 2=pink, 3=red, 4=candy stripe and, or mixed.

[5] #37 Bolting Tendency without cold induction: 1=B-(annual)=100%, 2=bb(biennial)-0%, 3=B:bb(mixed) 1-99%.

[6] #61 Beet Western Yellows (BWYV): 0=immune; 1=very resistant; 3=resistant; 5=intermediate; 7=susceptible; 9=highly susceptible based upon yellowing of leaves. Mean disease ratings (DI) from Aug. 22, and Sept. 25, 1990.

[7] #74 Rhizomania: 0=no visual symptoms; 1=very minor root symptoms; 3=normal tap root, slight bearding; 5=wine-glass shaped, bearded, moderate damage; 7=severely damaged, loss of tap root; 9=dead due to rhizomania.

[8] 64 entries = 57 PI lines from Ames plus checks. Checks are: US H11=highly susc. to rhizomania, mod. resistant to BWYV; C39=moderately resistant to BWYV and rhizomania.

Conclusion: No types were found with BWYV resistance as good as C39 check. No individual plants were observed with high resistance or immunity to BWYV. Variability occurred for reaction to rhizomania but no line was as resistant as C39R; no individual plants within lines were observed that had resistance to rhizomania. For BWYV and rhizomania, no individual plants or lines were selected for reevaluation and/or incorporation into the breeding program at Salinas.

STUDIES ON SOIL BORNE PATHOGENS OF SUGARBEET

J. S. GERIK and J. C. Hubbard

EFFECT OF Fosetyl-Al ON RHIZOMANIA: Preliminary non-replicated studied performed in the greenhouse indicated that Fosetyl-Al may have some activity against infection by *Polymyxa betae*. Studies were conducted in the greenhouse and field to determine if any activity did exist. A greenhouse test was conducted using infested field soil (clay loam) collected from the rhizomania disease nursery at the USDA station in Salinas. Plastic pots (4" X 4" X 4") were filled with the soil (60 in^3) and planted with seed of 'USH11' sugarbeet. Treatments consisted of an application at seed level of 0.4g per pot of a granular formulation consisting of 10% fosetyl-AL and 5% iprodione by weight. This treatment approximated 35 lb fosetyl-AL and 17 lb iprodione per acre. Spray treatments consisted of 1 ml of a solution (0.02g / ml) of aliette fungicide (fosetyl-AL 80% WP) atomized on to each plant 2, 4, & 6 weeks after planting. The experiment was set up in a 2 factorial randomized complete block design with 4 replications. Every treatment entry was quadruped so that multiple samples could be assayed during the test. The plants were thinned to 1 per pot. Plants were index for BNYVV by double antibody sandwich ELISA (DAS-ELISA) 1, 3, 5, and 7 weeks after planting.

A field experiment was conducted in the rhizomania nursery at the USDA station in Salinas. A split-split plot was designed with 8 replications. The plots were single row (28") wide and 33' long with 3' alley between reps. Main plots consisted of an in-furrow application of the 10% fosetyl-AL and 5% iprodione granular material at rates of 0 and 0.15 g per row ft. Sub-plots were sprayed with a solution of aliette at a rate of 0.20 g per row ft 2, 2 & 4, or 2, 4, & 6 weeks after planting, or left un-sprayed. Sub-sub-plots consisted of the sugarbeet hybrids 'USH11' or 'Rhizosen'. Plants were sampled from each plot 24 days following planting, then every 2 weeks for a total of four sampling dates. The samples were indexed for infection of BNYVV by DAS-ELISA. The plot was planted 22 June, 1990 and harvested 15 November, 1990. Yield data were collected at harvest time.

Results

The data from the greenhouse experiment is presented in Table 1. The data indicate that neither the granular or spray application had any affect on infection by BNYVV.

During the course of this experiment phytotoxic symptoms appeared on the plants which was thought to be due to the granular material. To determine if the phytotoxic symptoms were due to the granular formulation of fosetyl-AL and iprodione another experiment was prepared. The same soil used previously was mixed with the granular formulation at a rate of 1000 ppm of the material to dry weight of soil in a twin shell blender for 1 hour. Serial dilutions (1:1) were made with the same soil. Each dilution was also mixed for 1 hour. Seven dilutions were made so that a total of 8 concentrations of the material existed, ranging from 1000 ppm to 7.5 ppm plus the soil alone (0.0 ppm). Five reps per concentration were evaluated. Two weeks after

planting, plants growing in soil treated with all concentrations of the material were showing phytotoxic symptoms. Six weeks after planting the plants were assayed for infection of BNYVV. Only the plants growing in the highest concentration of material had significantly lower incidence of infection by BNYVV, but these plants were very much damaged by the material (Table 2).

The results of the field test were similar to the greenhouse experiment. There was no indication that either the granular or spray applications of fosetyl-AL decreased the incidence of infection of BNYVV (Table 3) Also, the incidence of infection between the varieties was not different for all the sampling dates (data not shown).

The yield data collected included clean root weight, % sucrose, gross sucrose, and % tare (Table 4.). These values were significantly different between the varieties (Table 5); the resistant hybrid 'Rhizosen' had more favorable values than 'USH11'. The yield data were not significantly different for any of the chemical treatments (at $P \leq 0.05$), though the spray treatments exhibited a trend for reduced tare ($P = 0.094$). A near significant interaction between the granular treatment and variety was observed for root weight ($P = 0.0549$) and gross sugar ($P = 0.0660$). The trend in this interaction was that the granular material lowered the yield of only the resistant variety.

Discussion

The conclusion reached by reviewing the data reported in this study is that fosetyl-AL does not inhibit the infection by *P. betae* and BNYVV. Only at exorbitantly high rates (1000 ppm) was there a significant reduction in infection. The diminished infection at this very high rate of fungicide may have been caused by a massive phytotoxic effect on the roots, rendering them non-infectible by *P. betae*. During the course of the tests, phytoxic effects of the granular were evident in both the greenhouse as well as the field test. No phytoxic effects were seen when the wetable power was applied as a foliage spray. The effect of the granular application on the resistant variety is an interesting phenomenon. The data suggest that the granular application may actually lower the yield of the resistant variety. Whether or not this apparent reduction is a interaction with the disease resistance is not known.

Table 1. Number of sugarbeet plants, treated and not treated with a granular and/or spray application of fosetyl-AL, infected with beet necrotic yellow vein virus in a greenhouse experiment 1, 3, 5 & 7 weeks after planting.

	Number of Infected Plants[1]			
Treatment	1 week	3 weeks	5 weeks	7 weeks
Control	4	4	3	2
Granular	2	4	4	1
Spray		4	4	3
Granular + Spray		3	3	3
X^2 values[2]	0.267	3.200	2.286	2.794

[1]Total of 8 plants per treatment for first week, then 4 plants per treatment thereafter.
[2]All Chi-square values indicate no significant differences.

Table 2. Number of healthy and diseased sugarbeets growing is soil mixed with varying concentrations of 10% fosetyl-AL and 5% iprodione granular fungicide six weeks after planting.

Concentration (ppm)	Healthy	Diseased
0.0	0	5
7.5	0	5
16.8	0	5
33.7	1	4
62.5	0	0[1]
125	2	3
250	1	3
500	1	1
1000	4	1

$X^2 = 14.4$, $P = 0.044$

[1]Totals of healthy and diseased plants that do not equal 5 indicate mortality.

Table 3. Number of sugarbeet plants, treated and not treated with a granular and/or spray application of fosetyl-AL, infected with beet necrotic yellow vein virus in a field experiment 24, 38, 52 & 66 days after planting

Treatment	Number of Infected Samples[1]			
	24 days	38 days	52 days	66 days
Control	7[2]	12	12	10
Granular	12	10	12	12
1 Spray	27[3]	11	14	13
2 Sprays		27[4]	12	13
3 Sprays			13	13
Granular +				
1 Spray	32[3]	13	14	14
2 Sprays		25[4]	8	13
3 Sprays			15	14
X^2 values[5]	4.420	3.657	11.702	4.440

[1]Samples consisted of 3 plants for the first date and single plants thereafter.
[2]Total number of samples was 16 unless noted.
[3]Total number of samples was 48.
[4]Total number of samples was 32.
[5]All Chi-square values indicate no significant differences.

Table 4. Root yield, % sucrose, gross sugar and tare values from a field experiment treated and not treated with a granular and/or spray application of fosetyl-AL, and planted with a susceptible ('USH11) and resistant ('Rhizosen') hybrid under severe rhizomania conditions.

Affect	Treatment	Root Weight (lb/plot)	% Sucrose	Gross Sugar (lb/plot)	Tare (%)
Granular	Control	25.3	10.1	2.8	33.2
	Treated	23.8	10.1	2.6	34.4
Spray	Control	23.8	10.2	2.6	41.5
	1 Spray	25.5	10.2	2.8	31.8
	2 Sprays	25.0	10.1	2.7	30.7
	3 Sprays	23.8	9.8	2.5	31.4
Hybrid	USH11	13.7	8.2	1.1	4.8
	Rhizosen	35.4	12.0	4.2	19.0
Granular X Hybrid					
Control:	USH11	13.5	8.2	1.1	47.7
	Rhizosen	37.0	12.0	4.4	18.8
Treated:	USH11	13.8	8.2	1.1	49.7
	Rhizosen	33.7	11.9	4.0	19.1

Table 5. *F* values[1] and error mean square values for four parameters from a field experiment treated and not treated with a granular and/or spray application of fosetyl-AL, and planted with a susceptible ('USH11) and resistant ('Rhizosen') hybrid under severe rhizomania conditions.

Source of variation	df	Root weight	% Sucrose	Gross sugar	Tare
Reps.	7	5.53**	2.47	3.76*	5.88**
Granular	1	1.36	0.01	1.55	0.48
Error mean square	7	51.92	1.21	0.59	92.1
Spray	3	0.62	0.60	0.83	2.28*
Granular X Spray	3	0.60	1.66	0.98	0.62
Error mean square	2	38.18	1.54	0.51	365.64
Hybrid	1	560.72**	529.42**	772.86**	103.70**
Granular X Hybrid	1	3.84*	0.11	3.51*	0.08
Spray X Hybrid	3	0.62	0.38	0.92	1.78
Granular X Spray X Hybrid	3	0.76	0.16	0.58	0.67
Error mean square	56	26.88	0.86	0.40	272.82

[1]Coefficients followed by two asterisks are significant at $P \leq 0.05$; those with one asterisk at $P \leq 0.10$.

EFFECT OF SOIL MATRIC POTENTIAL EFFECTS ON INFECTION BY *POLYMYXA BETAE* AND BNYVV. Soils, varying in texture, were collected from four fields known to be infested with rhizomania. The soils were placed in cylinders (4 cm X 5 cm diameter), planted with 'USH11', and saturated with water. The soils were then immediately adjusted to soil moisture potentials between -200 and -400 mbars. The cylinders were sealed in plastic beakers and incubated at 24° C for 14 days. After this time the plant roots were removed from the soil and indexed for infection by BNYVV by ELISA and for *P. betae* by microscopic examination.

RESULTS

The soil texture classes and particle size distributions are listed in Table 1. The soils were all heavily infested with *Polymyxa betae* and BNYVV.

The results of the experiment conducted with the four soils are presented in Table 2. In general, infection was greater in the lighter texture soils at the higher matric potentials. Infection at the lowest matric potential appeared to be reduced, but still occurred to some extent.

DISCUSSION

The results of the experiment are somewhat inconclusive because soil matric potentials were not tested at levels sufficiently low to limit all infection. The data do point out that infection can take place at relatively dry soil moisture conditions.

The data indicate that soil texture may interact with the matric potential requirements for infection, especially in wetter soils. Frequency of infection appear to be greater in the courser texture soils compared to the clay soil; however, the inoculum densities of the different soils were not standardized and this observation could be erroneous.

The method used in this experiment to adjust soil matric potential did not provide constant soil moisture conditions during the entire experiment, but only provided defined conditions at the time of planting. Experiments utilizing more exacting techniques should be performed to obtain better data concerning the effect soil matric potential has on infection.

Table 1. Texture and particle size distribution of soils.

	%		
Soil Class	Sand	Silt	Clay
Clay	26.0[1]	12.5	61.5
Clay Loam	31.5	29.5	39.0
Sandy Loam	76.0	6.5	17.5
Loamy Sand	74.0	12.0	14.0

[1]Values are the mean of 2 analyses.

Table 2. Effect of soil matric potential at planting on infection by *Polymyxa betae* and BNYVV.

	Number of Infected Plants out of 4[1]				
	Matric Potential (- mbars)				
	200	250	300	350	400
Clay	1	2	0	2	1
Clay Loam	4	4	1	0	0
Sandy Loam	4	3	4	2	1
Loamy Sand	4	4	4	1	2

[1]Infection determined by ELISA test 14 days after planting.

STUDIES ON SOIL INOCULUM DENSITY OF *POLYMYXA BETAE* AND BNYVV: Soil was collected from several sugarbeet fields in California and was assayed for the number of infecting units of *Polymyxa betae* and BNYVV using a most probable number (MPN) technique. These assays provided information as to the inoculum density in sugar beet fields known to be heavily infested with *P. betae* and BNYVV. Additional studies were conducted with soil collected from 2 field plots fumigated with 0, 9, or 12 gallons/acre of 1,3-dichloropropene.

Greenhouse test were conducted to determine the effect of different inoculum levels on infection and disease severity of young sugarbeet seedlings under controlled conditions. In this experiment sterilized soil was infested with inoculum. The soil was serially diluted (1:1) 19 times for a total of 20 soils each with 1/2 the inoculum as the one before. Sugarbeets were grown in these soils for 8 weeks, after which data on plant growth and disease was collected.

RESULTS

The inoculum levels of six San Joaquin Valley fields and the disease nursery in Salinas are reported in Table 1. These fields all have very severe rhizomania. The inoculum densities of 2 fields fumigated with 1,3-dichloropropene are presented in Table 2. The inoculum levels were reduced by the fumigant, but based on the above data, not to levels that one would expect would control disease.

The inoculum levels of samples from the artificially infested soil was determined by the MPN method. The inoculum concentration for all the dilution levels was extrapolate from this value and is listed in Table 3. Infection was detectable down to 2 infecting units per kg of soil. As each plant was growing in 150 g of soil, this concentration represents an average of 0.30 infecting unit per plant container (Table 3.). The disease date is presented in Fig. 1. The factors measured indicate that significant damage occurs at inoculum levels as low as 0.13 infecting units per g of soil.

DISCUSSION

The results suggest that inoculum levels in severe rhizomania fields are at least 100 times greater than levels which will cause very severe damage under controlled conditions. The use of soil fumigants to control rhizomania will only work if the fumigation reduces the inoculum levels drastically. In this study fumigation did not reduce the inoculum level to levels low enough that one would expect disease control. The field plots subsequently showed little or no affect of the fumigation treatment (T. Babb personal communication, data not shown). One must conclude that under ideal disease conditions, field inoculum levels which are detectable, are sufficiently high to cause serious disease.

Table 1. Inoculum levels of BNYVV and *P. betae* in soils from seven California sugarbeet fields.

Field	Infecting Units/ g Soil	
	BNYVV	*P. betae*
SJV1	2.8 ± 21[a]	9.6 ± 8.8
SJV-2	5.0 ± 2.8	14.6 ± 4.9
SJV-3	1.2 ± 0.7	61.0 ± 27
SJV-4	1.2 ± 1.2	3.7 ± 2.8
SJV-5	15.4 ± 4.6	293.0 ± 128
SJV-6	4.8 ± 2.2	19.5 ± 8.6
SALINAS	16.4 ± 3.5	22.0 ± 1.4

[a]The values represents the mean of four assays ± the standard error.

Table 2. Inoculum levels of BNYVV and *P. betae* in soils from two California sugarbeet fields fumigated with 0, 9 or 12 gal / acre of 1,3-dichloropropene.

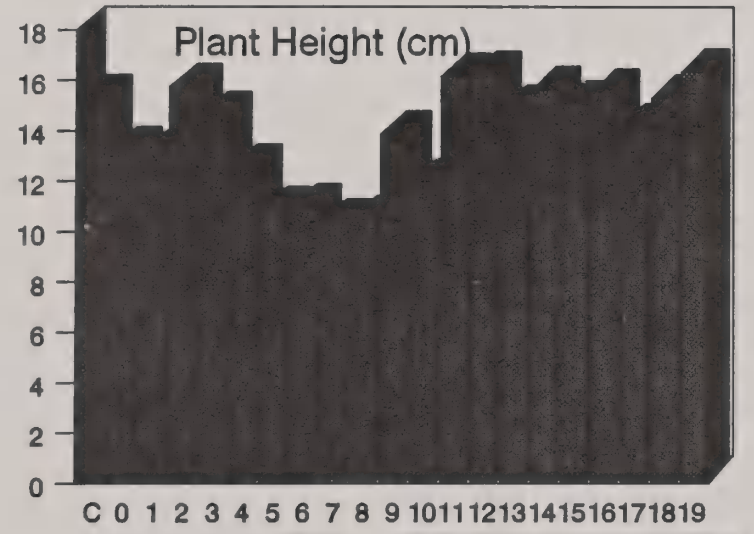
Field:	Infecting Units / g. Soil			
	SJV-5		SJV-6	
	BNYVV	*P.betae*	BNYVV	*P. betae*
Control:	15.4 ± 4.6[a]	293.0 ± 128	4.8 ± 2.2	19.5 ± 8.6
9 gal.	1.9 ± 1.2	14.6 ± 8.9	4.5 ± 1.7	9.1 ± 3.1
12 gal.	3.0 ± 1.5	73.0 ± 40	10.6 ± 8.5	26.6 ± 21.6

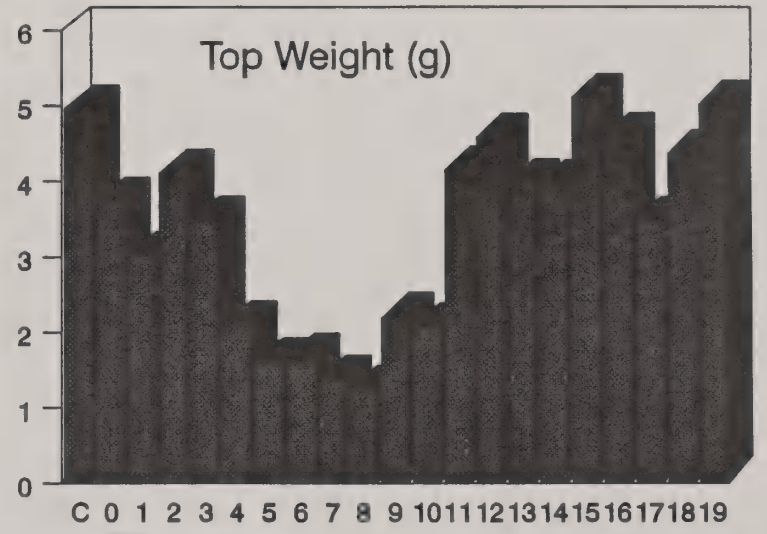
[a]Values represents the mean of 5 reps ± the standard error.

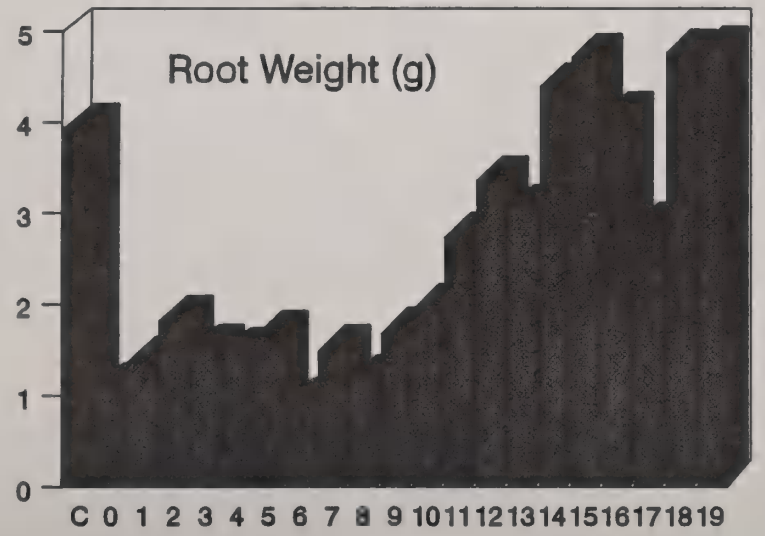
Table 3. Infecting units (IUs) of BNYVV in artificially infested, diluted soils, and number of infected plants, out of 4 reps.

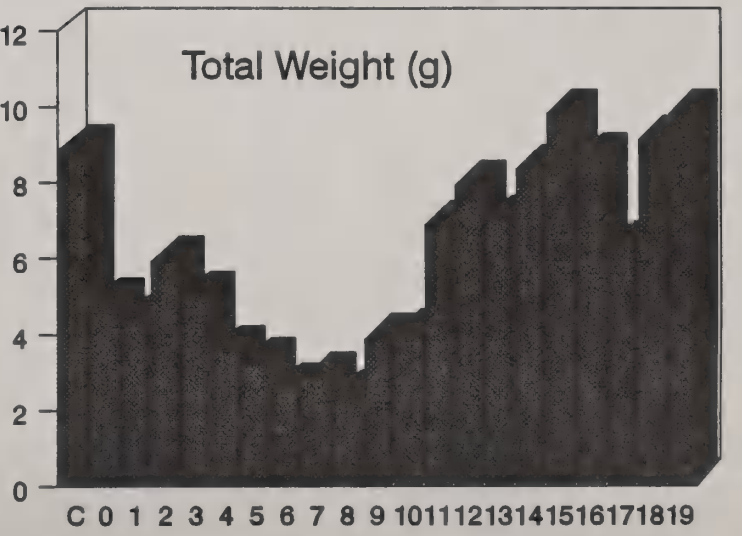
Dilution#	IUs/g of soil	IUs/container	No. Positive
0	132	19774	4
1	66	9887	4
2	33	4944	4
3	16.5	2472	4
4	8.2	1236	4
5	4.1	618	4
6	2.06	309	4
7	1.03	154	4
8	0.55	77	4
9	0.26	39	4
10	0.13	19	4
11	0.064	9.7	4
12	0.032	4.8	4
13	0.016	2.4	3
14	0.008	1.2	2
15	0.004	0.60	4
16	0.002	0.30	1
17	0.001	0.15	0
18	0.0005	0.08	0
19	0.0003	0.04	0

Fig. 1. Measured parameters from inoculum dilution experiment. Soil was serially diluted with sterile soil. "C" indicates control.









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SUGARBEET RESEARCH

1990 Report

Section B

Plant Molecular Biology Laboratory
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Dr. Russell O. Nordeen, Molecular Biologist

The research was supported in part by funds provided through the Beet Sugar Development Foundation (Project 800)

CONTENTS

Owens, L. D. and C. A. Wozniak. 1991. Measurement and effects of gel matric potential and expressibility on production of morphogenic callus by cultured sugarbeet leaf discs. Plant Cell Tiss. & Org. Cult. In press.

During studies to optimize the production of morphogenic callus from cultured leaf discs of sugarbeet (*Beta vulgaris*, REL-1) large differences were observed associated with the gelling agent employed. Water availability, as determined mainly by gel matric potential, was found to be the dominant factor. A simple method was devised to measure the relative matric potential of different gels. A precisely moistened filter-paper disc was placed on the gel surface, allowed to equilibrate, removed and weighed. The relative gain or loss of water from the paper disc was a measure of the matric potential of the gel and varied with both gel type and concentration. Leaf disc expansion and production of callus-derived embryos and shoots were shown to be directly proportional to gel matric potential. Water availability may also be affected by the ease with which liquid is expressed from gels in response to localized pressure caused by explant expansion and contortion. This property, called gel expressibility, was easily measured with a weight and capillary pipette and shown also to vary with gel type and concentration. Validity of the technique for measuring relative matric potential was verified physiologically by culturing leaf discs on filter-paper overlays to eliminate expressibility differences among gels. Additionally, comparison of leaf disc growth on uncovered gel surfaces versus filter-paper overlays demonstrated the contribution of liquid expression to overall water availability. Expression of liquid by explants on uncovered gel surfacees greatly enhanced the production of morphogenic callus.

Nordeen, R. O., S. L. Sinden, J. L. Jaynes and L. D. Owens. 1991. Lethal concentration analysis of cecropin SB37 for bacterial phytopathogens and their hosts. Plant Physiol. Suppl. In press.

Cecropin SB37 is a low molecular weight polypeptide (4 KD) that is a synthetic derivative of cecropin B, a natural component of an inducible humoral defense system in various insects. Preparatory to introducing the synthetic gene encoding SB37 into selected plant species we analyzed the lethal concentration of SB37 with respect to bacterial plant pathogens and protoplasts of their respective hosts. Lethal concentrations for the phytopathogens tested ranged from 0.3 µM for *Pseudomonas syringae* pv *glycinea* to 3.1 µM for *P. syringae* pv *tomato*. Lethal concentrations for protoplasts from twelve plant cultivars representing eight plant species ranged from 2.6 µM for *Solanum tuberosum*, to 55.5 µM for *Beta vulgaris*. The relatively wide range of lethal concentrations of SB37 between certain bacteria and protoplasts of their plant hosts suggests it may be possible to obtain protective levels of cecropin expression in transgenic plants of these species.

TISSUE CULTURE OF SUGARBEET FOR GENE TRANSFER

L. D. Owens and C. A. Wozniak

Our recent investigation on the importance of water availability to the growth of sugarbeet leaf discs and subsequent production of morphogenic callus has led to an improved protocol for gene transfer experiments. Leaf discs (4 mm) of REL-1 are dipped briefly in a suspension of *Agrobacterium* carrying the genes to be transferred, blotted and cocultured for 2 days on moistened filter paper overlaying medium solidified with 0.2 % Gelrite. Following a 2-day coculture period the discs are transferred to the same culture arrangement containing antibiotic to kill the agrobacteria. The filter paper overlay provides a physical support that gives excellent disc growth free from bacterial overgrowth. Kanamycin (100 µg/ml) selection is withheld for 14 days to permit initiation of callus growth. At about 7 weeks morphogenic callus and small (< 3mm) shoots are removed and cultured on medium with the sole hormone benzyladenine (BA) lowered from 1 to 0.25 mg/L. Shoots > 3mm are cultured on medium without hormone to lessen the tendency towards vitrification and to condition the shoot before planting on rooting medium. Kanamycin selection is imposed at all times to lower the frequency of escapes. Leaf pieces from shoots >1 cm are screened for reporter gene (β-glucuronidase) activity using the histochemical assay. Currently, several dozen shoots obtained with this protocol are being characterized.

A potentially simpler method of delivering DNA into sugarbeet cells involves use of a biololistic microprojectile delivery system -- the "gene gun". With tobacco, suspension cells have proved a convenient target, and transgenic plants have reportedly been obtained in this fashion. Sugarbeet suspension cell cultures were initiated from leaf disc callus of REL-1, but regenerability diminished rapidly with subculturing -- presumably due to habituation. Cells cultured in PG_0 medium containing 0.25 BA in the dark, however, were observed to segregate into two cell types -- small densely cytoplasmic cells in large aggregates and large transparent cells in aggregates consisting of only a few cells. When transferred to solid medium containing 0.25 to 1 mg/L BA and placed in the light the latter cells grew rapidly in an undifferentiated manner. The large aggregates of densely cytoplasmic cells, however, underwent embryogensis under the same conditions. Further development of this suspension culture system may provide regenerable suspension cells suitable for bombarding with DNA-coated beads.

ENGINEERING RESTANCE TO BACTERIAL PATHOGENS

R. O. Nordeen and L. D. Owens

Cecropin SB37 is a synthetic derivative of cecropin B, a small inducible polypeptide (37 amino acids in length) in insects that is involved in defense against bacterial pathogens. Cecropins act by inserting into the membrane of bacteria rendering them leaky and causing cell death. In modifying the gene for use in plants we have used an overlapping polymerase chain reaction (PCR) strategy to fuse DNA encoding a secretory peptide to the coding region of the gene. The secretory leader is designed to target the mature cecropin to the intercellular spaces of the plant wherein reside the invading bacteria. In accomplishing this fusion it was necessary to add several amino acids to the N-terminus of the hypothesized mature polypeptide in order to maintain the protease cleavage site. We have used chemically synthesized derivatives of cecropin B to test the activities of specific modifications of the molecule against both the pathogen and the host plant.

A modification of the thin-agar plate assay was developed for use with both bacteria and plant protoplasts. Either bacteria or protoplasts were incorporated into molten agarose and poured into a Petri dish to form a 1 mm deep layer. After hardening, wells (2 mm dia.) were formed by suction and a 1 ml pipette. A dilution series of the model cecropins was then introduced into the wells. At appropriate times inhibition zones were measured and the lethal concentration calculated.

Lethal concentrations for 14 plant-pathogenic bacteria tested ranged from 0.3 to 3.1 μM of cecropin SB37. The values for two strains of *Erwinia carotovora* subsp. *betavasculorum*, which causes bacteria vascular necrosis and rot in sugarbeet, were 1.0 and 2.6 μM. The lethal concentration for sugarbeet protoplasts was 55.5 μM -- at least 20-fold higher than its pathogen. The toxicity differential between the two may be a conservative estimate since protoplasts of tobacco that were permitted to form cell walls before being exposed to cecropin withstood levels about 8 times higher than did protoplasts. The relatively high tolerance of sugarbeet cells in comparison to bacteria suggests it may be possible to obtain protective levels of cecropin expression in transgenic sugarbeet.

Preliminary tests indicate that MB39, the cecropin derivative corresponding to our engineered gene product, was only slightly less active than SB37. A derivative having 3 additional amino acids at the N-terminus (MB42) was only about one-fourth as active. The relationship between periodicity of positive charges at the N terminus and biological activity bear further investigating.

The MB39 gene construct was inserted into an *Agrobacterium* vector and used to obtain transgenic tobacco plants. These plants were selfed, and the T_2 plants are now being characterized.

SUGARBEET RESEARCH

1990 REPORT

Section C

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Dr. E. G. Ruppel, Plant Pathologist
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Cooperation:

Colorado Agricultural Experiment Station

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Contents

Publications

Abstracts of Papers Presented, Published, or Approved for Publication.

Hecker, R. J. 1991. Effect of root size on combining ability of sucrose yield components. J. Sugar Beet Res. 28:(in press)

Definitive information is lacking about the effect of sugarbeet root size on combining ability (CA) for recoverable sucrose components. Four cycles of mass selection in a heterogeneous population for large and small roots with no change in sucrose content resulted in two lines with different root weight but the same sucrose. These lines and their source served as pollinators of a set of five diverse male sterile testers. The 15 resultant hybrids were subjected to CA analyses. Significant general and specific combining ability (GCA and SCA) variances occurred for root yield and sucrose content. Male GCA effects for sucrose indicated that the selection had effected additive gene changes without shifting the mean. There were no differences due to SCA. For root yield there were SCA effects but no male GCA differences. Repartition of the variance into three male x female sources revealed root yield and sucrose differences due to small root effects but no differences due to large roots. Breeding conclusions were that large roots should be avoided in order to increase potential SCA for both root yield and sucrose content.

Hecker, R. J. and M. E. McClintock. 1991. Use of sugarbeet pollen for genetic assay and selection. J. Sugar Beet Res. 28: (abstract in press)

Pollen is a unique plant tissue that is potentially useful for genetic assay and selection. Methods were explored with sugarbeet pollen to assay for disease resistance and heterosis, and to select for tolerance to cold, salinity, and aluminum. Several pectolytic and cellulosic enzymes known to be produced by *Rhizoctonia solani* had no consistent differential effect on in vitro germination and K^+ leakage of pollen from root rot resistant and susceptible sugarbeets. Pectin lyase produced by a root rotting strain of *R. solani* had a potent negative effect on pollen germination but no resistance differentiating power. Cercosporin toxin reduced pollen germination and generally increased K^+ leakage, but did not discriminate between leaf spot resistant and susceptible pollen sources. Four cycles of low temperature challenge of pollen during fertilization showed evidence of genetic gain for cold tolerance. Three cycles of a more intense in vitro cold challenge of pollen gave a modest genetic gain in one of two separate lines, the gain being detected by measurements in both pollen and seedlings. Pollen challenged by salinity for 3 cycles resulted in more salt tolerant pollen but no change in plants. Challenge of pollen for aluminum tolerance is in the first cycle. Pollen-stigma complementation vs. heterosis for root yield showed a positive relation but, if used, would result in the discard of some lines potentially good as parents for hybrids. Pollen size and variance were unrelated to sporophytic heterozygosity, hybrid vigor, and combining ability. Cryopreserved pollen appears to have lost 69% of its original viability after 5 years.

Hecker, R. J. and E. G. Ruppel. 1991. Registration of Rhizoctonia root rot resistant sugarbeet germplasm FC 710. Crop Sci. 31: (in press)

Sugarbeet germplasm FC710 was developed, released, and registered by USDA-ARS.

FC710 is a diploid multigerm germplasm that is resistant to root rot caused by *Rhizoctonia solani*. FC710 was developed and released for use as a pollinator or as a source germplasm for development of pollinators in the breeding of *Rhizoctonia*-resistant hybrid cultivars by sugarbeet breeders. FC710 was developed by nine cycles of mass selection and two cycles of recurrent selection from an original population that included U.S. cultivars (42%), germplasms tolerant to *Cercospora beticola* and *Aphanomyces cochlioides* (28%), biennial *Beta maritima* (15%), and other regionally adapted sugarbeets (15%).

Hoefert, L. L. and S. S. Martin. 1991. Trap crops for the sugarbeet cyst nematode (Heterodera schachtii). I. Structure. J. Sugar Beet Res. 28: (abstract in press)

Nematodes are attracted to some members of the Brassicaceae, notably species of radish and *Sinapis*. These plants have been widely planted in Europe as cover crops to aid in the attraction and removal of nematodes from sugarbeet fields. The techniques have met with considerable success abroad. Our approach has been to look at the seeds and seedlings of the trap crops to see if any structural anomalies may exist that could explain the attraction of nematodes to the cover crops. We have begun the investigation into the distribution of specialized cells in seedlings and dry seeds during hydration. Quantitative data have been collected that indicate higher numbers of specialized cells occur in the non-trap crop Brassicaceae species but that the size of the specialized cells is greater in trap crop species. Electron microscopy during development shows that the specialized cells differentiate in a manner similar to laticifers in latex-bearing plants, but that the cell content differs. In the specialized cells, glucosinolates or their precursors accumulate via endoplasmic reticulum cisternae that fuse with the central vacuole to produce a cell lumen filled with the glucosinolate materials.

Martin, S. S. 1990. Flavonoid phytoalexins are synthesized by diverse Beta vulgaris. J. Sugar Beet Res. 27:(in press)

The ability of diverse *Beta vulgaris* to synthesize the flavonoid phytoalexins betagarin and betavulgarin was examined in 35 lines, including such diverse phenotypes as sugarbeet, table beet, fodder beet, and chard. Plants were field-inoculated with *Cercospora beticola* to produce Cercospora leaf spot disease. Extracts of necrotic lesions from leaves of every line contained the isoflavone phytoalexin betagarin, whereas the flavone betavulgarin sometimes was not detected. The genetic capacity to activate the multiple biochemical pathways leading to accumulation of betavulgarin may be presumed to require constant selection, and the maintenance of this capaciaty in such genotypically varied lines is consistent with the presumed role of betavulgarin in resistance to Cercospora leaf spot.

Martin, S. S. 1991. Trap crops for the sugarbeet cyst nematode (Heterodera schachtii). II. Biochemistry. J. Sugar Beet Res. 28:(abstract in press)

Root exudates of plants of the Brassicaceae are uniquely effective in attracting the sugarbeet cyst nematode. Members of this plant family also produce a unique group of biologically active chemicals, the glucosinolates (abbreviated GSL), which might be involved in the effect. I analyzed the GSLs in radish (*Raphanus sativus*) and mustard *Sinapis alba*) trap crop cultivars, and determined their

concentrations in seeds, developing seedlings, and leaves and roots of mature plants. Samples were extracted in boiling 75% methanol (8 min.), evaporated to remove methanol, made to known volume with distilled water, filtered (0.2μ, and analyzed by HPLC (C_{18}-column; gradient elution with 3% [aq.] acetic acid and acetonitrile mixtures; diode array UV detection; electronic integration). All samples of *S. alba* contained one predominant GSL, 4-hydroxybenzylglucosinolate (glucosinalbin); three others were present in trace amounts. Glucosinalbin increased rapidly in early development, and was greater in the epicotyl than in the hypocotyl. Seed of *R. sativus* 'Maxi' contained 4-methylsulfinylbut-3-enyl-glucosinolate (glucoraphenin) as its predominant GSL, but germinating seedlings (including both hypocotyls and epicotyls) rapidly synthesized the unoxidized analog, glucoraphasatin (4-methylthiobut-3-enylglucosinolate), its content equaling or exceeding that of glucoraphenin by 72-96 hr. Small amounts of glucosinalbin and 4-hydroxy-3-indolylmethylglucosinolate also occurred in *R. sativus*. Roots and tops of mature radish plants differed in GSLs.

Narum, J. A. and S. S. Martin. 1991. Sugars and impurities in peel and interior of Beta vulgaris: Changes under high-quality storage. J. Sugar Beet Res. 28:(abstract in press)

Two major factors are important in loss of sucrose from sugarbeets during pile storage: respiration, and biochemical conversions to compounds such as invert sugar and raffinose. As part of a broader investigation of peel biochemistry, our objective in this study was to determine the rate of loss of sucrose and changes in other impurities in the peel versus peeled interior of sugarbeets harvested and held under nearly ideal conditions. Sugarbeets from commercial, smooth root, and experimental varieties were stored at 4 C and nearly 100% humidity. Whole root (RT), interior (IN), and peel (PL) samples were collected at harvest and after 8, 16, and 24 weeks of storage. Biochemical changes were monitored by analyzing aluminum-clarified sucrose filtrate samples for pol sucrose; sodium and potassium (flame photometer); amino-N (ninhydrin); weight loss on drying; and "true" sucrose, glucose, fructose, raffinose, and betaine (HPLC). At harvest, "true" sucrose comprised 14.71%, 14.78%, and 3.01% of RT, 12.82% (IN), and 2.22 % (PL) after 24 weeks. During high quality storage, mean raffinose content (g/100 g LC sucrose) approximately doubled in RT and IN, but increased 3½-fold in the peel.

Narum, J. A., S. S. Martin, and K. H. Chambers. 1991. Sugars and impurities in Beta vulgaris cultivars after pile storage. J. Sugar Beet Res. 28:(abstract in press)

Differences among sugarbeet cultivars in ability to maintain high quality during storage are of interest to growers and processors. We followed biochemical changes in sugarbeets grown and pile stored at three factory locations, which had different environmental conditions. Six varieties were held for 110 days at location #1, five varieties were held for 90 days at location #2, and two varieties were held for 49 days at location #3. Samples collected at harvest and after pile storage were analyzed for pol sucrose; amino-N (ninhydrin); sodium and potassium (flame photometer); and "true" sucrose, raffinose, glucose, fructose and betaine by HPLC. Pol sucrose was higher in all samples than "true" sucrose during storage. After storage, "true" sucrose decreased by 1.94 to 5.18 (% of fresh weight) in the varieties tested at location #1, and 0.11 to 0.86 in those at location #2. Small or no sucrose losses were found under the short-term

storage at location #3. Post-storage raffinose, glucose, and fructose levels (g/100 g LC sucrose) increased in all cultivars at all locations.

Ruppel, E. G. 1991. Pathogenicity of Fusarium spp. from diseased sugar beets and variation among sugar beet isolates of F. oxysporum. Plant Dis. 75:(in press)

Sugar beets (*Beta vulgaris*) with symptoms of Fusarium yellows were collected from fields in California, Colorado, Montana, Oregon, Texas, Wyoming, and Manitoba, Canada, during 1982-1988. Forty-eight isolates of seven species of *Fusarium* and two nonsporulating, unidentifiable "Roseum" types were obtained from root tissue on a medium selective for *Fusarium* spp. Three isolates of *F. oxysporum* (the reported causal agent of Fusarium yellows) from California, one each from Colorado and Texas, and two each from Montana, Oregon, and Canada, a Colorado isolate of *F. acuminatum*, two isolates of *F. avenaceum* from Texas, and one "Roseum" type from Colorado all caused foliar yellowing, wilt, root necrosis, and in some cases eventual death of sugar beet seedlings in greenhouse tests. Two isolates of *F. solani* (from California and Colorado) induced mild to moderate root rot of seedling taproots and secondary roots but no typical yellows symptoms. Of the isolates that were pathogenic to seedlings, only isolates of *F. oxysporum* and the Colorado isolate of *F. acuminatum* induced typical Fusarium yellows symptoms in wound-inoculated 3-mo-old sugar beets in the greenhouse. Other isolates pathogenic on seedlings induced some necrosis of secondary roots and arrested, necrotic lesions on the taproot of older sugar beets but no wilting, foliar yellowing, or plant death. All virulent and avirulent isolates were reisolated from surface-disinfested roots 30 days after planting in infested soil or 2 mo after inoculation of taproots. Isolates of *F. oxysporum* varied in growth, pigmentation, and conidial production on potato-dextrose agar. A significant isolate X cultivar disease interaction occurred when two sugar beet breeding lines, one susceptible and one resistant, were tested with four isolates of *F. oxysporum* from diverse geographic areas. In separate analyses of data from the resistant and susceptible breeding lines, the four isolates varied in virulence toward the susceptible but not the resistant line. Thus, the existence of physiological specialization among isolates of *F. oxysporum* from sugar beet remains an unresolved question.

Ruppel, E. G. 1991. Trap crops for the sugarbeet cyst nematode (Heterodera schachtii). III. Susceptibility to fungal pathogens of sugarbeet. J. Sugar Beet Res. 28:(abstract in press)

Three cultivars of the mustard *Sinapis alba* (3-9001, 3-9002, & 'Maxi') and one radish (*Raphanus sativus* 'Nemex') were planted in pathogen-infested soil or inoculated in the greenhouse with sugarbeet fungal pathogens and evaluated for disease 21 or 30 days later. *Aphanomyces cochlioides* induced 20-26% seedling damping-off in mustards, 50% in radish, and 87% in sugarbeet. Damping-off caused by *Pythium ultimum* ranged from 0-47% in mustards, 22-35% in 'Nemex,' and 37-45% in sugarbeet, whereas *P. aphanidermatum* induced 35-100% damping-off across the trap crops and sugarbeet, stand loss being dependent on environmental conditions. *Rhizoctonia solani* AG-4 caused 45-67% damping-off in trap crops and 92% in sugarbeet. *R. solani* AG-2-2 induced 34-68% seedling loss in the trap crops and 97% in sugarbeet. *Fusarium oxysporum* var. *betae* caused 100% seedling loss in sugarbeet, 19% in 'Maxi,' 8% in 3-9001, and no loss in 3-9002 or 'Nemex.' *F. avenaceum* reduced stands in sugarbeet, 'Maxi,' and 3-9001 by 86, 5, and 8%,

respectively; 'Nemex' was not susceptible. *Cercospora beticola* induced a few leaf spots in the cotyledons and older leaves of the trap crops. Powdery mildew, *Erysiphe polygoni* (= *E. betae*), failed to infect the trap crops. Susceptible trap crops, incorporated as green manure, may serve as inoculum reservoirs for subsequent sugarbeet crops.

RHIZOCTONIA ROOT ROT RESEARCH AND DEVELOPMENT OF GENETIC RESISTANCE IN SUGARBEET (BSDF Project 402)

1990 Field Research on Rhizoctonia Root Rot of Sugarbeet.--R. J. Hecker and E. G. Ruppel.

This project primarily involved field research conducted on the Colorado State University South Campus on a land area reserved for our Rhizoctonia root rot research. Our ARS Rhizoctonia research project involves cooperation of the BSDF and Colorado State University. We are pleased to be able to lead this three-way cooperative research effort.

The 1990 field experiments were planted on an area that had been in barley for the previous 3 years and was the site of our inoculated Rhizoctonia nursery in 1986. In 1990, no rhizoctonia root rot occcurred from residual fungus before inoculation. Hence, the dense population of *Rhizoctonia* in the soil in 1986 essentially had been inactivated during the intervening 3 years of barley culture. All Rhizoctonia evaluation experiments were planted in one-row plots 56 cm (22 in) apart, and 6.1 m (20 ft) or 4.3 m (14 ft) long. Experiments were planted May 15 and thinned June 25-29. Dry, ground, barley-grain inoculum of *Rhizoctonia solani* (R-9) was banded at 1.97 or 3.11 g/m over each row with a tractor-mounted four-row granule applicator. Experiment 4R, involving resistant germplasms, received the higher rate of inoculum, whereas all other experiments with more susceptible germplasms received the lower rate. Inoculation was done July 19, and our standard sprinkler irrigation regime was used to moisten and activate the inoculum. Succeeding irrigations were done by furrow.

Roots in all experiments were lifted September 17-21 and individually rated for rot. Disease index (DI) ratings were on a scale of 0 to 7, with 0 = no evidence of infection and 7 = plant dead. The percentage of healthy roots were those with DIs of 0 and 1, roots showing no active infection. The roots with DIs 0 through 3 also were analyzed as a class; these roots were sufficiently sound and large to be recovered in a commercial harvest. The epiphytotic of root rot in our 1990 Rhizoctonia experiments was relatively mild compared to previous years but provided good relative evaluations of all germplasms.

Germplasm Development and Genetic Improvement of Rhizoctonia Root Resistance.--R. J. Hecker and E. G. Ruppel.

One of the objectives of Project 402 is the development of sugarbeets resistant to root-rotting strains of *Rhizoctonia solani*. That basic objective is close to being achieved. The breeding scheme we have used over the years has yielded, thus far, about 24 breeding lines which have been released to the industry from 1972 through 1990. These lines each have had modestly improved resistance compared with previously released lines. We are now at the point where our most resistant breeding lines are highly resistant to root rotting strains of *R. solani*.

Based on our resistance inheritance studies done in the past, we believe that our most resistant lines have an accumulation of genes for resistance. This is a quantitative multigenetic condition that causes resistance against all tested AG-

2-2 strains of the pathogen.

Most of our germplasm releases from this project have been multigerm. We have purposely maintained as much genetic variability as possible for sucrose production characteristics. By design, we have tried to maintain relatively good general combining ability, so that breeders might select high-combining, resistant parental lines for commercial hybrids. We have released one monogerm CMS and O-type, FC708CMS and FC708. Other monogerm CMSs and O-types are in our breeding program and are being readied for release. Less advanced in our program are lines that incorporate Rhizoctonia resistance with resistance to curly top, leaf spot, and rhizomania. These are in both monogerm and multigerm backgrounds.

We have shown in past research that there is little heterosis for Rhizoctonia resistance, only an average of about 5-10% dominance for resistance. Therefore, to achieve the highest level of resistance in hybrids, it is necessary to have high levels of resistance in all parents of a hybrid. Whether or not the highest level of resistance is necessary clearly depends on the disease potential of the field to be planted.

We also have shown that there is a resistance dosage effect of triploid hybrids over diploids when the pollinator is a resistant tetraploid and the CMS is a susceptible diploid. This dosage effect is a means of enhancing resistance. However, an autotetraploid is no more resistant than the diploid from which it was derived.

Comparisons of resistance among our breeding lines and various other entries in our 1990 field test are shown in Table 1. The best line in the test was FC714 (entry 460), with a disease index (DI) of 0.9. This is a monogerm, O-type that currently is being increased for release in the fall of 1991. It is designed to bring resistance to the female side of hybrids. We have not made a CMS equivalent of FC714. FC709 (entry 482) is a recent multigerm release. It has excellent rhizoctonia resistance and good leaf spot resistance, but it is curly top susceptible. Other new multigerms of potential value in breeding programs are entries 487, 518, 522, 507, 501, 491, 519, 506, 504, et al. These entries represent introgressions of Rhizoctonia resistance into various high combining, high sucrose, and other desirable genetic backgrounds.

Table 1. Means for Rhizoctonia root rot assessment of germplasms in various stages of resistance development; 1990 inoculated field test.

Entry	Germplasm & description[2]	Disease index[1]	Healthy roots (%)	Harvestable roots[1] (%)	Leaf spot rating	Curly top rating	Sucrose %	Kg root/ 20' plot
453	FC707-2	1.1	91	98	--	--	14.1	15.51
454	FC712	1.2	85	96	4.0	7.7	13.1	14.14
455	HH32; Rh tolerant hyb	2.1	56	78	--	--	--	--
457	ACH184; Rh tolerant hyb	1.9	60	84	--	--	--	--
459	MH E4	3.8	29	45	3.0	--	--	--
460	FC714; mm, OT, Rh	0.9	96	100	4.5	--	13.5	15.78
461	(SynFC701/LSR-CTR)aa//C718, 2 cy Rh	2.0	70	82	--	--	--	--
462	Syn(FC701/LSR-CTR)//C718, 3 cy Rh; mm, OT	3.0	39	67	--	5.3	--	--
463	C718CMS//Syn(FC701/LSR-CTR); CMS, mm	2.8	37	72	--	5.1	--	--
464	Syn(FC701/LSR-CTR)//C718, 2 cy Rh; mm, OT	3.1	35	71	--	6.1	--	--
465	C718CMS//syn(FC701/LSR-CTR); CMS, mm	1.5	73	93	--	--	--	--
466	C718/FC708, BC_1P_1; 2 cy Rh; mm, OT	2.6	44	78	--	6.5	--	--
467	C718/FC708, BC_1P_1; 1 cy Rh; mm, OT	2.8	38	73	--	--	--	--
468	C718/FC708, 3 cy Rh; mm, OT, Rh-CTR	2.4	39	83	--	6.0	--	--
469	C718CMS/FC708, 3 cy Rh; mm, Rh-CTR	1.9	59	90	--	6.0	--	--
470	C718/FC708, 3 cy Rh; mm, OT	2.3	40	89	--	6.6	--	--
471	FC702/LSR-CTR; 6 cy Rh; mm, OT	1.6	69	95	--	--	--	--
472	FC708; mm, OT, Rh, reindexed	1.4	79	97	--	7.6	--	--
473	FC708CMS	1.2	80	100	--	--	--	--
474	EL44/FC708, 3 cy Rh; mm, OT	1.8	64	88	--	--	--	--
475	EL44CMS/FC708, 3 cy Rh; mm	2.0	48	91	--	--	--	--
476	FC705-1; high Rh resist check	1.3	76	97	--	--	--	--
477	C37/FC707-2, 3 cy Rh; MM, CTR	1.6	75	91	--	5.8	--	--
478	FC607/FC708, 3 cy Rh; mm, LSR	2.4	53	76	--	--	--	--
479	FC607CMS/FC708, 3 cy Rh; mm, LSR	1.7	70	90	--	--	--	--
480	FC609/FC708, 4 cy Rh; mm, OT, LSR	2.6	49	75	--	--	--	--
481	FC609CMS/FC708, 4 cy Rh; mm; LSR	1.5	69	94	--	--	--	--

Table 1. (continued)

Entry	Germplasm & description[2]	Disease index[1]	Healthy roots (%)	Harvestable roots[1] (%)	Leaf spot rating	Curly top rating	Sucrose %	Kg root/ 20' plot
482	FC712/mono309, 2 cy Rh; MM	1.8	72	86	--	--	12.8	14.58
483	FC709; MM, Rh, LSR	1.0	93	100	3.5	7.3	13.5	13.80
487	(FC607CMS/FC708)2 cy RH//FC709	1.1	88	99	--	--	13.5	18.05
488	SP6323-01CMS/FC708//FC709	1.3	77	95	--	--	14.2	16.54
489	(662119s1CMS/FC502-2//FC504///FC708)3 cy Rh, CMS////FC709	1.6	68	89	--	--	14.4	15.23
490	1861CMS/FC708//FC709	1.4	71	97	--	--	14.5	17.15
491	Comm Rh hybs, 5 cy Rh; mm, S-cyto, non-OT	1.5	77	92	--	--	14.1	--
492	R920; MM, rhizomania resist	2.6	43	77	--	--	--	--
493	R820, 1 cy Rh; MM, rhizomania resist	2.2	49	82	--	--	--	--
494	R720, 1 cy Rh; MM, rhizomania resist	1.5	76	95	4.0	--	--	--
496	Rh susc check	4.8	13	29	--	--	--	--
497	(FC607CMS/FC708)2 cy Rh//comm Rh hybs, 5 cy Rh	1.4	78	94	--	--	13.3	15.87
498	1861CMS/FC708//comm Rh hybs, 5 cy Rh	1.8	64	84	--	--	13.5	15.71
499	662119s1CMS/FC606//comm Rh hybs, 5 cy Rh	2.3	48	75	--	--	--	--
500	FC609CMS/comm Rh hybs, 5 cy Rh	2.0	56	83	--	--	--	--
501	Two comm hybs, 5 cy Rh; MM, S-cyto, non-OT	1.3	80	96	--	--	--	--
502	662119s1CMS/562//two comm hybs, 5 cy Rh	2.1	50	78	--	--	12.4	18.85
503	FC703-5/Peramono, 2 cy Rh; MM	1.6	66	92	--	--	11.5	18.15
504	ACH14/FC708, 4 cy Rh; S-cyto, MM	1.8	68	90	--	--	14.7	11.62
505	FC708/ACH14, 4 cy Rh; N-cyto, MM	2.0	62	82	--	--	14.5	14.17
506	FC703/three high suc, 6 cy Rh; MM	1.6	69	91	3.3	--	16.7	14.44
507	USSR MM, 7 cy Rh; mm	1.3	76	98	--	--	--	--
508	FC710; MM	1.4	77	96	4.0	6.5	14.3	13.79
509	FC705-1; MM	1.2	85	99	--	--	13.5	8.97
510	PI 285593 1 cy Rh; bb, rrYY	1.9	46	95	--	--	--	--
511	PI 293420 1 cy Rh; bb, RRYY, globe	1.9	51	95	--	--	--	--

Table 1. (continued)

Entry	Germplasm & description[2]	Disease index[1]	Healthy roots (%)	Harvestable roots[1] (%)	Leaf spot rating	Curly top rating	Sucrose %	Kg root/ 20' plot
512	Rh resist check; FC703	1.9	65	84	--	--	--	--
513	FC701/LSR-CTR; mm, OT	1.9	56	93	3.5	7.8	--	--
518	Comm hybs/FC708, 4 cy Rh; MM, S-cyto, non OT	1.1	86	99	--	--	--	--
519	Polish 2x-4-73mm/FC709, 5 cy Rh; MM	1.5	74	91	--	--	--	--
522	C37/FC702-2, 1 cy Rh	1.2	86	95	--	--	--	--
523	C718CMS/FC708, 1 cy Rh	2.0	56	84	--	--	--	--
524	C718CMS//SynFC701/LSR-CTR	2.0	57	86	--	--	--	--
--	FC712/Mono309, 2 cy Rh; Rh, MM, non-OT	--	--	--	--	8.0	--	--
--	Mono309/FC712, 2 cy Rh; Rh, MM, non-OT, S-cyto	--	--	--	--	6.7	--	--
--	C37	--	--	--	--	5.0	--	--
--	Curly top check; US33	--	--	--	--	5.7	--	--
--	Leaf spot susc. check	--	--	--	6.3	--	--	--
--	Leaf spot resist check	--	--	--	3.5	--	--	--
--	LSD (p=.05)	0.7	--	--	1.6	--	2.5	3.13

[1]Disease index = 0 (no disease) to 7 (all plants dead); healthy roots = no infection or small arrested lesions; harvestable roots = roots sufficiently large and sound to be included in a grower's harvest.

[2]MM = multigerm; mm = monogerm; Rh = Rhizoctonia resistant; LSR = leaf spot resistant; CTR = curly top resistant; non-OT = Non O-type; S-cyto = sterile cytoplasm; cy Rh = cycles of selection for Rhizoctonia resistance.

Some monogerm CMS and O-type pairs of potential interest are entries 481 and 480, 479 and 478, and others that are breeding efforts for combined Rhizoctonia and leaf spot resistance on the female side of hybrids.

Curly top-Rhizoctonia resistant combinations are multigerm entries 522 and 477; monogerm CMS and O-type entries are 475 and 474, 467 and 468, 463 and 462. R720, R820, and R920 (entries 494, 493, and 492) are succeeding generations of a rhizomania-tolerant line, which Dr. Lewellen (USDA, ARS, Salinas, CA) has developed from our Rhizoctonia-resistant lines. Improved rhizomania tolerance (R720 to R920) has been accompanied by an apparent decline in Rhizoctonia resistance. R720 and R820 in this test actually are progeny populations after one cycle of reselection for Rhizoctonia resistance. Germplasm such as this will be valuable for areas plagued by both Rhizoctonia root rot and rhizomania.

An example of expected resistance in hybrids is demonstrated in entries 487, 488, 489, and 490. These 3-way hybrids each had 75% of their genes from resistant lines FC708 and FC709. The other 25% were from sources with varied levels of susceptibility. The resultant four hybrids had DIs and % harvestable roots of 1.1 (99%), 1.3 (95%), 1.4 (97%), and 1.6 (89%), respectively. The differences among these four hybrids was due to 25% of the resistance (or susceptibility) genes that originated from the CMS parent.

The most resistant germplasm developed under this project, although not immune to *R. solani*, suffered little loss in our tests when inoculated with a virulent strain of the pathogen. In a succeeding section of this report, a resistant hybrid (75% from resistant parents) suffered a 4% root loss due to root rot, compared with a 48% loss for a susceptible commercial hybrid. There were inoculated and disease-free treatments in the experiment. From this experiment, and observations in the past, we believe that hybrids that were made homozygous for the resistance genes in our most resistant lines would suffer little loss in growers' fields, even where root rot may have been a serious problem in the past.

Effect of Sugarbeet Leaf and Root Extracts on In Vitro Growth of Rhizoctonia solani.--E. G. Ruppel.

Selection in sugarbeet for resistance to *Rhizoctonia solani*, the cause of serious seedling damping-off and rot of mature roots, is hampered by the necessity of testing artificially inoculated germplasms in the field. Field testing not only is costly and time consuming, but breeding lines with only small degrees of resistance subsequently may be lost to secondary rots or continued pathogen activity during thermal induction to promote flowering. A simple, nondestruct, in vitro test for resistance would provide a rapid preliminary test for resistance, thereby reducing the number of germplasms that would have to be tested in field nurseries.

Materials and Methods.--Highly resistant sugarbeet cultivars FC 707(4x) and FC 709, moderately resistant commercial cultivars HH 32 and ACH 184, and highly susceptible cultivars FC 901 and commercial hybrid Monohikari were grown in the greenhouse until the plants had ample foliage and root tissue for experimental use (approximately 3 months). Root- and leaf-extract agar and broth media then were prepared by bringing 25 g of tissue to a boil in 80 ml distilled water, simmering for 15 min, straining through glass wool, and bringing up to 100 ml

with distilled water. For solid media, 1.5 g agar was added to each 100-ml of diluted extract. All media were dispensed in 125-ml flasks (20 ml/flask) and autoclaved for 30 min. Agar media then were poured into 9-cm-diameter petri dishes and left to solidify. After media had cooled, a 4-mm-diameter plug from a 4-day-old culture of *R. solani* (sugarbeet isolate R-9; AG-2-2) was transferred to each flask and to the center of each petri dish. Colony diameters on agar media were measured at 1 and 3 days after transfer. Mycelia from broth cultures were harvested after 8-days growth, rinsed with distilled water, dried in an oven for 24 hr, and then weighed to determine dry weight. Factorial experiments were arranged in randomized complete block designs with four replicates in each of two trials. Data were subjected to analyses of variance.

Results and Discussion.--Neither radial growth on agar media nor mycelial dry weight in broth media were correlated with degree of genetic resistance of the test cultivars, regardless of whether the media were prepared with root or leaf extracts. Variances between trials were significantly different.

The methods used for these tests were inadequate for distinguishing degrees of resistance in sugarbeet cultivars. Failure of these tests may be due to thermal lability of any preexisting chemical determinant of resistance, insufficient concentration of any determinant in the prepared media, or the absence of such a determinant(s) in sugarbeet.

Survival of Rhizoctonia in Soil Under Natural Conditions: Second-Year's Results.--E. G. Ruppel.

Rhizoctonia solani, the cause of damping-off and root rot in sugarbeet, survives for long periods in soils high in organic matter. Western soils are very low in organic matter content (usually <2%), and there is little information available on the longevity of the fungus in such soils or in buried, infected root debris. Knowledge is needed on pathogen survival to help determine cultural management practices for control of the fungus.

Materials and Methods.--The experimental site, design, and methodology were described in Sugarbeet Research, 1988 Report, pages C11 to C16. Herein are the results of the second trial, which extended from June 1989 through June 1990.

Results and Discussion.--Results of the first trial are reported in Sugarbeet Research, 1988 Report, pages C11 through C16, and Sugarbeet Research, 1989 Report, pages C16 to C17. In 1989-90, results differed slightly from 1988-89. In 1989-90, the fungus was recovered from debris buried 5 cm deep at every assay (Fig. 1A), whereas in the first trial, the fungus was not recovered after October; however, there was an 87% decrease in samples yielding the fungus by June 1990. Greater recovery at the shallow depth (5 cm) in 1990 compared with 1989 may be due to cooler soil temperatures recorded during the summer in trial 2. At the 10- and 20-cm depths, only 7 and 20% of the debris samples, respectively, yielded the fungus by the second assay (October 1990). In 1988-89, no 10-cm debris sample yielded the fungus after the first assay (August), except for December when *R. solani* was unexplainedly recovered from 40% of the samples at this depth. The percentage of debris samples yielding the pathogen 2 mo after burial (August 1990) was only 27% for all depths.

The percentages of soil samples from 5, 10, and 20 cm deep that yielded the fungus at the first assay (August 1990) were 49, 36, and 25%, respectively (Fig. 1B). These percentages dropped slightly over time and, by June 1990, they were 21, 17, and 15%, respectively.

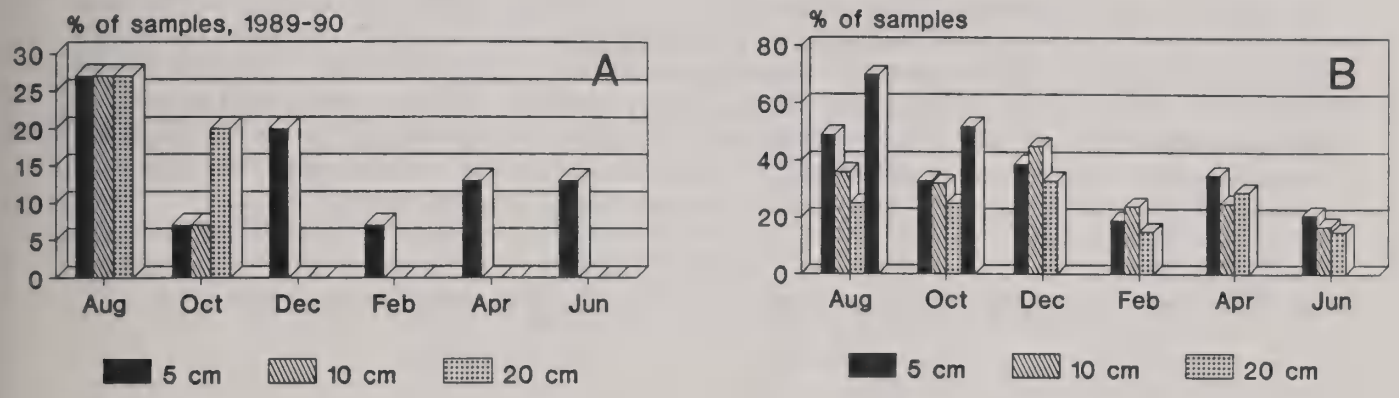


Fig. 1. Percent of 1989-90 samples yielding *Rhizoctonia solani* from infected sugarbeet roots buried at three depths (A) and from soil adjacent to the buried roots (B) as determined by assays on a *Rhizoctonia*-selective medium.

A random sample of 10% of all recovered isolates was tested for pathogenicity in sugarbeet in the greenhouse. All tested isolates from debris and soil were highly virulent and induced root rot in 3-mo-old beets.

Conclusions: *Rhizoctonia* populations rapidly decreased from sugarbeet root debris after introduction of infected debris into relatively dry, fallow soil, regardless of depth of burial to 20 cm. Population densities in soil surrounding the buried debris also decreased from 51-75% within 2 mo of the initiation of the experiment; however, the pathogen could be recovered throughout the year-long period in both trials. That the fungus persisted (albeit in much reduced density) year round, substantiates the recommended minimal 3-yr rotation scheme to reduce root rot incidence in subsequent beet crops in many, but not all, Western soils.

Virulence of Rhizoctonia Anastomosis Groups in Sugarbeet and Radish.--E. G. Ruppel.

The soilborne fungus *Rhizoctonia solani* exists as strains that are genetically different from each other. Based on their ability to form hyphal bridges (i.e., anastomoses) between isolates, the strains are separated into "anastomosis groups" (AG). Isolates that anastomose are genetically similar and are placed within a certain AG. To date, nine AGs have been identified, along with a "bridging group," which forms anastomoses with several other AG types. Preliminary to a study on the effects of biocontrol agents on different anastomosis groups, we wanted to determine whether the isolates in hand were pathogenic to sugarbeet and radish.

Rhizoctonia solani AG-1, -2-1, -2-2, -3, -4, -5, -6, -7, -8, -9, and BI (bridging isolate) were grown on moist, sterile barley grain for 3 wk. Colonized grain (10 grains/pot) were placed on the soil surface of 10-cm-diameter pots containing pasteurized soil. The grains were covered with 1-cm of soil, and 25 seed of sugarbeet or radish were distributed equidistant on the soil surface. Seed then was covered with an additional 1-cm layer of pasteurized soil; the pots were irrigated immediately and thereafter as needed. Damping-off was recorded 14 days postplanting. A factorial experiment was arranged in a randomized complete block design with three replications; the experiment was repeated once. Because error variances of the two trials were homogeneous, sums of squares were pooled for an overall analysis of variance. Damping-off was calculated as a percentage of control seedlings in uninfested soil. Percentages were transformed to arcsine-square roots for analyses, but actual percentages are presented here.

The *Rhizoctonia* isolates induced 3-100% damping off across the test plant species, and there was a highly significant isolate X crop interaction (Fig. 1).

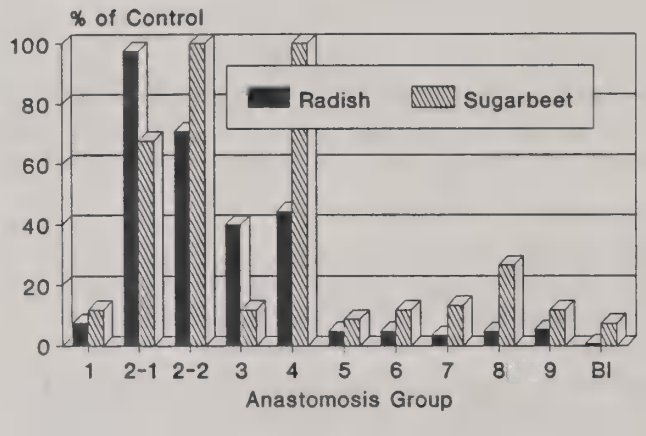


Fig. 1. Damping-off of sugarbeet and radish by isolates of ten anastomosis types of *Rhizoctonia solani* as percentages of uninoculated controls.

Isolates AG-2-1, -2-2, and -4 were most virulent in both sugarbeet and radish, inducing 44-100% seedling death. Isolate AG-3 induced 40% damping-off in radish but only 12% in sugarbeet. Isolate AG-8 caused 27% damping-off in sugarbeet but only 5% in radish.

Conclusions: Because only one isolate of each AG type was tested, little can be concluded about virulence of AG types as a whole. However, for those isolates on hand, only three were highly virulent in sugarbeet (AG-2-1, -2-2, and -4). Isolates AG-2-2 and -4 originally were isolated from sugarbeet. Isolate AG-2-1 was obtained from Japan and may or may not have been obtained from sugarbeet.

Effect of Rhizoctonia Root Rot on Yield of Sugarbeet Varieties with Varied Degrees of Resistance.--E. G. Ruppel and R. J. Hecker.

Because of concern among sugarbeet breeders and sugar producers that there might be some loss of root or sucrose yield in hybrids developed with resistance to *Rhizoctonia solani* even though disease symptoms may be mild or absent, a test to resolve this concern was needed. We report herein the results of our second year's data; results of 1989 were detailed in Sugar Research, 1989 Report, pages C15-C16.

Five sugarbeet entries were planted in the field in our *Rhizoctonia*-inoculated nursery. Entries varied in their level of resistance from susceptible (HM 55) to moderately resistant (HH 32, ACH 184) to highly resistant (FC 709 and [FC505CMS/FC708//FC712]). The experiment was planted May 18 in four-row, 6-m-long plots, with four replicates in a randomized complete block design. One-third of the plots (random) were inoculated on July 19 (60 days postplanting), and another third on July 30 (70 days postplanting). A third of the plots were not inoculated. Two inoculation dates were used to preclude complete death of the susceptible cultivar. In early October, the two center rows of each plot were lifted; rated for root rot on a scale of 0-7, with 0 = no rot and 7 = plant dead; topped; washed; weighed; and analyzed for sucrose and thin-juice purity by standard procedures. Data for all parameters were subjected to analysis of variance and regression and correlation analyses as appropriate. Percent data were transformed to arcsine-square roots for analyses.

Disease index, root yield, recoverable sucrose, percent sucrose, and percent purity are given in Figures 1-5. Generally, the early inoculation induced more root rot and decreased yields more than the later inoculation, as was expected. Also, there was a direct relationship between disease severity and the yield parameters for the susceptible HM 55 and the moderately resistant HH 32. Reduction in root yield and other yield parameters were not as great in ACH 184 or the experimental three-way hybrid (FC505/FC708//FC712), the latter having two genomes from resistant pollinators. Except for root yield, with a reduction of 9-15%, yield losses in the resistant breeding line FC 709 also were little affected due to the disease, as compared with HM 55 and HH 32.

Conclusions: Further analyses of our data are needed for definitive conclusions, and we plan to repeat this experiment in 1991. However, from our results we believe that there were no hidden yield losses due to *Rhizoctonia*, as measured in our inoculated nursery. It appears that there is a linear relationship between disease index and the yield parameters and that our most resistant three-way hybrid was little affected by the pathogen.

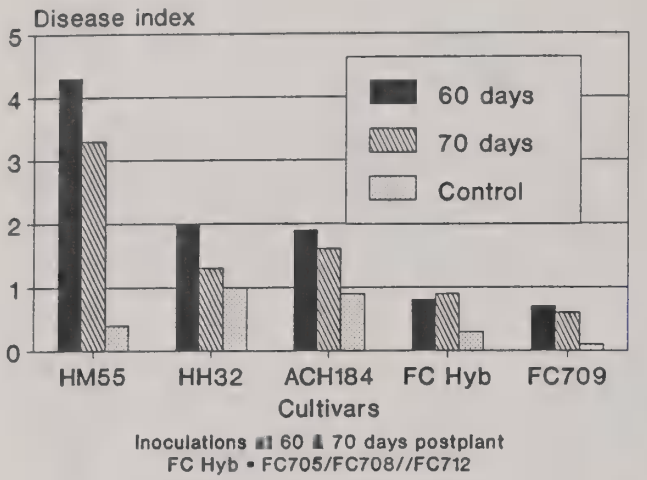


Fig. 1. Disease index of sugarbeet cultivars artificially inoculated with *Rhizoctonia solani* on two dates in the field.

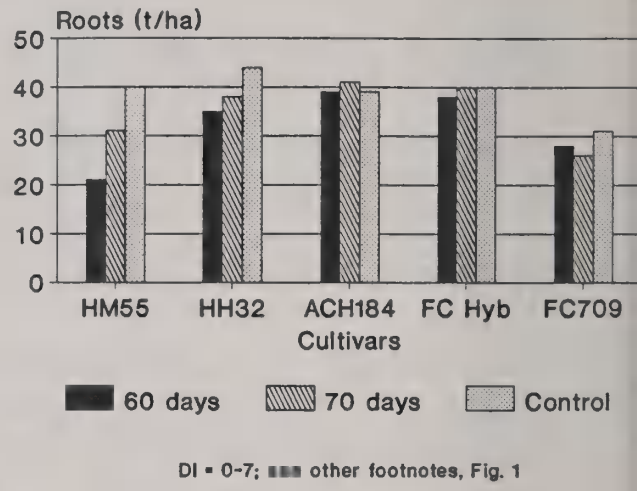


Fig. 2. Root yield of sugarbeet cultivars artificially inoculated with *Rhizoctonia solani* on two dates in the field.

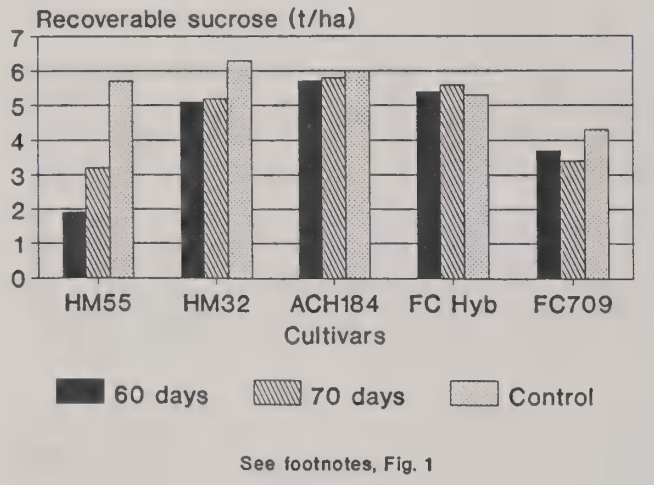


Fig. 3. Recoverable sucrose from sugarbeet cultivars artificially inoculated with *Rhizoctonia solani* on two dates in the field.

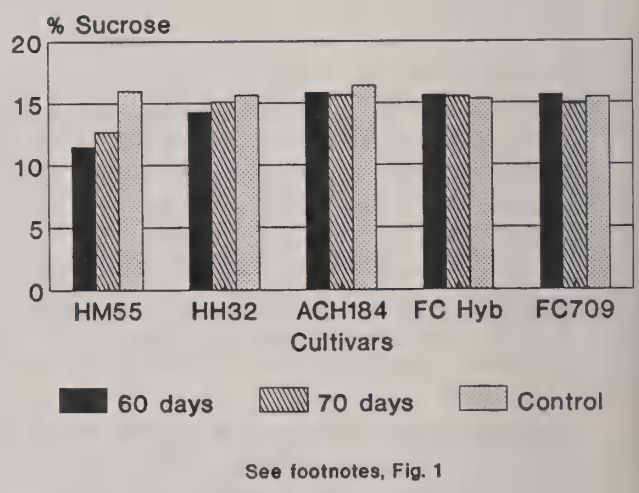
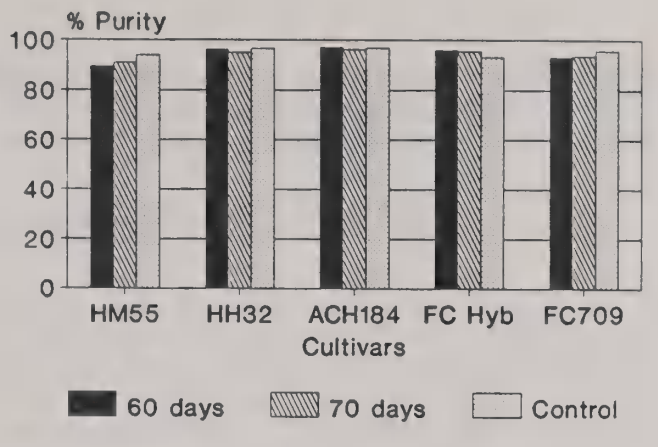


Fig. 4. Percent sucrose of sugarbeet cultivars artificially inoculated with *Rhizoctonia solani* on two dates in the field.



See footnotes, Fig. 1

Fig. 5. Percent raw-juice purity of sugarbeet cultivars artificially inoculated with *Rhizoctonia solani* in the field.

EVALUATION OF CONTRIBUTED LINES FOR RESISTANCE TO RHIZOCTONIA ROOT ROT (BSDF Project 903)

E. G. Ruppel and R. J. Hecker

Randomized complete block designs with five replicates were used to evaluate 169 contributed lines from seven companies; additionally, one company also had another test with three replicates. Rhizoctonia-resistant line FC 703 and highly susceptible FC 901 were included as internal controls, along with highly resistant FC 705/1. The experimental design, methods, results, and statistical analyses were provided to the appropriate company breeders.

Although environmental conditions were conducive for Rhizoctonia root rot and our inoculum tested extremely virulent in the greenhouse, our 1990 field epidemic was relatively mild compared with past nurseries. Mean disease indices (DIs; scale of 0-7, with 7 = dead) for FC 705/1, FC 703, and FC 901 across all tests were 1.3, 1.5, and 3.8, respectively. Percent healthy means were 78.7, 68.6, and 17.2, whereas percent roots in classes 0 through 3 were 96.2, 91.8, and 46.5, respectively. DIs of contributor lines ranged from 1.3 to 6.1, and from 0 to 88% healthy roots.

EVALUATION OF CONTRIBUTED LINES FOR RESISTANCE TO CERCOSPORA LEAF SPOT (BSDF Project 904)

E. G. Ruppel and G. A. Smith

Randomized complete block designs with three or two replicates were used to evaluate 165 contributed lines from BSDF-member companies and two cooperators. Internal controls included a highly susceptible synthetic and a resistant check, FC(504 X 502/2) X SP6322-0. Two-row plots were 4 m long with 56 cm between rows and a 20- to 25-cm within-row plant spacing. We inoculated twice (June 29 and July 6), and evaluations were made on August 16, 21, and 28, and on September 4, when the peak of the epidemic was reached.

At the peak of the epidemic, leaf spot severity was greater than in 1989. On September 4, the resistant and susceptible controls had mean disease indices of 4.1 and 6.9 (scale of 0-10), respectively, across all tests. Means of contributor lines ranged from 3.7 to 8.5. Means of the individual tests were tabulated, statistically analyzed, and sent to the appropriate contributor.

IN VITRO POLLEN TECHNOLOGY TO ASSAY AND SELECT FOR ECONOMIC CHARACTERS IN SUGARBEET (BSDF Project 403)

R. J. Hecker and M. E. McClintock

The objective of this project is development of in vitro techniques with sugarbeet pollen or other tissue to assay plants or populations for genotype or genetic worth, and to make genetic selection. Our in vitro studies this year were focused in three areas: (a) enzymes as an in vitro test, (b) morphological comparisons of susceptible and resistant plants, and (c) pollen tests. We used enzymes associated with pathogens to assess for genotypic differences between lines which are susceptible or resistant. Other studies, suggested by in vitro research, involved anatomical and morphological comparisons of Rhizoctonia susceptible and resistant sugarbeets. Our pollen tests were primarily tests of the hypothesis that genetic characteristics of the sporophyte can be identified and/or selected in the gametophyte (pollen). Because pollen is haploid and many genotypes are contained in a watch glass, it can be manipulated somewhat like microorganisms. When compared to callus or suspension culture, the use of pollen is advantageous because genetic characteristics cannot be hidden by dominance or epistasis, as happens in all types of sporophytic tissues. Unlike these tissues, however, pollen is not regenerable and can be used only to fertilize male-sterile flowers that probably have not been subjected to the same challenge or selection as the pollen; but this is not a serious problem because the rare pollen genotype(s) which survives the challenge and fertilizes an ovule will produce a heterozygous plant, presumably, that segregates relatively simply, so that conventional plant selection and breeding can be applied in succeeding generations.

Results for pollen challenge experiments and other experiments related to use of pollen as a tissue for sugarbeet breeding are reported in the following sections.

In Vitro Assay for Resistance of Sugarbeet to Rhizoctonia solani and Cercospora beticola.

We continued our research involving commercially available pectolytic and cellulasic enzymes which are similar to those produced by *R. solani*. These enzymes were used on known Rhizoctonia susceptible and resistant sugarbeets to determine if detectable differences in leaf, root, or pollen response could be seen. Enzymes tested in the past year were cellulase I, pectolyase, and pectinase. Experiments involved a variety of methods as well as sugarbeet plant materials. Testing involved enzyme injection into root tissue, assessment of potassium leakage from root tissue and from pollen, and infusion of the enzymes into leaves.

Root experiments involving enzyme infusion:

For cellulase I, two roots each of two Rhizoctonia susceptible and resistant lines were tested. The method was the same as that used for neutral red infusion of roots (see discussion on anatomical differences between susceptible and resistant lines, succeeding Section 2). Intact greenhouse grown roots, 3 months old, were cut off at the crown and a solution of cellulase I (5 units/ml) was forced (using a plastic syringe without needle) into the exposed root surface. At 24 and 48 hours after infusion, the root was sliced into 5 mm sections. Enzyme treatment resulted in darkening and softening of roots at both periods but there was no apparent correlation with the degree of resistance.

For pectolyase, an experiment repeated the cellulase procedure (above), using the same lines and age of plants. Pectolyase, in a concentration of 50 units/ml, was injected and roots observed after 48 hours at 23C. Results were the same as for the cellulase experiment, no apparent relationship with degree of resistance.

Root experiments involving K^+ (potassium) leakage:

Pectolyase treatments, in previous studies, caused some differences between susceptible and resistant plants in infusion results as well as pollen germination studies. Therefore, we expected that differences in K^+ leakage from roots exposed to the enzyme might be detected. Greenhouse grown roots, about 2 1/2 months old, were cleaned and the shoot portion was removed. A cork borer was used to cut 6 shallow cores/root; disks with periderm intact were trimmed to a 2 mm thickness, rinsed, and immersed in a 10 unit/ml solution of pectolyase. After 4 hours at 23C, K^+ leakage of treatments and controls was measured by selective ion electrode. The enzyme caused leakage of K^+ of about 50 ppm from both susceptible and resistant root disks. Susceptible roots could not be differentiated from resistant roots by amount of K^+ leakage caused by exposure to pectolyase.

Pollen experiments involving K^+ leakage:

Since *Cercospora beticola* infection affects the permeability of cell membranes, leafspot resistant lines potentially could be characterized by the ability to resist this change in permeability. We used commercial enzymes, which tend to degrade cell walls and affect cell permeability, to assess pollen from susceptible and resistant Cercospora lines of sugarbeets. Using Sigma pectinase and cellulase type I, we measured potassium leakage after enzyme treatment of pollen from sources with varying leafspot resistances. No differences in leakage were detected from susceptible, intermediate, and resistant lines.

Leaf infusion experiments:

The effects of various enzymes were tested by infusion. They include commercially prepared enzymes as well as pectin lyase produced by *R. solani* (supplied by Dr. Bugbee, USDA, ARS, Fargo).

We used three commercially available enzymes as infusates on Rhizoctonia susceptible and resistant plants to test for differential reactions. Enzymes tested were cellulase type I, pectinase, and pectolyase. Infusion involved filling a plastic syringe with the appropriate enzyme, and pressing the tip to the underside of a leaf. Pressure was exerted on the syringe until a visibly wet spot about 3 mm in diameter could be seen on the leaf undersurface. After a period of time, usually 24 hours, the spots were examined for evidence of physical damage. In all experiments, a water control was used, but, except for occassional mechanical damage caused by pressure from the syringe tip, it had no effect; the "wet spot" was invisible later. In contrast, enzyme damage was visible in the form of brownish lesions or cleared spots in the leaf. For most enzyme experiments, water was perceptibly easier to infuse than enzyme, and susceptible plants, regardless of medium, were easier to infuse than resistant plants.

Cellulase type I was tested in two experiments. A preliminary experiment tested a range of enzyme concentrations and best times of observation for the production of visible lesions. In a second experiment, we used a total of 5 leaves, representing three plants from each line (one susceptible and one resistant). Five regions of the leaf were injected with enzyme (25 units/ml), with 6 lesions per region, for a possible total of 30 lesions. A sixth region was infused with a distilled water control (6 potential lesions).

The five leaves from each line were compared for presence of lesions after 24 hours. There was little differentiation between susceptible and resistant lines. Of thirty possible lesions, susceptible leaves had a mean of 29.6 and resistant leaves had a mean of 28.8.

Pectolyase, a second commercial enzyme, was used for similar testing on leaf tissues. We employed a range of concentrations (0-50 units ml), three different periods (0, 3, and 24 hours), and three plants each of a susceptible and a resistant line. Susceptible plants had significantly more lesions than resistant plants, with an enzyme concentration of 8 units/ml, when observed 3 hours after infusion (see Figure 1).

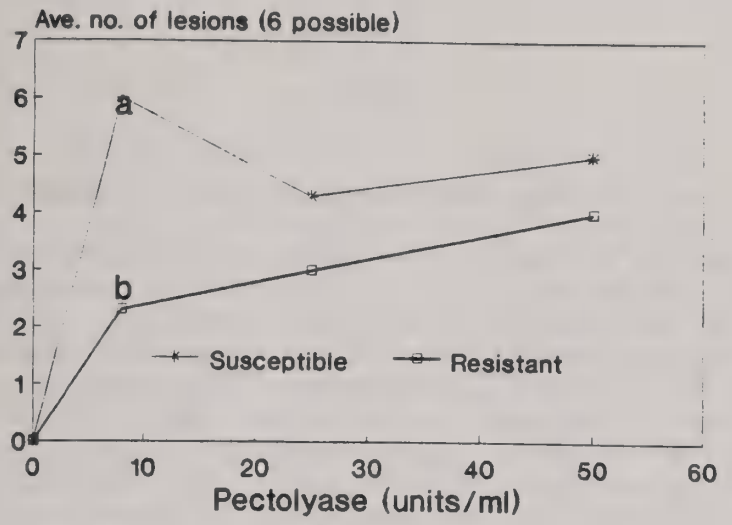


Fig. 1. Effect of pectolyase concentration on leaves.

A second experiment used the most effective concentration (8 units/ml) on two susceptible and two resistant lines. Enzyme lesions totaled 10/leaf, 2 leaves/plant, and 3 plants/line. After 5 days, the number of lesions was counted. Susceptible plants had 18 lesions for 12 leaves, or a mean of 1.5 lesions/leaf. Resistant plants had a total of 26 lesions for 12 leaves, a mean of 2.2 lesions per leaf. This trend is the opposite of that found in the previous experiment. A source of the variability may be differences in the leaf's ability to "accept" the enzyme. This source of variability was studied and is described in Section 2.

Pectinase is available in commercial preparations from two different companies: Sigma and Worthington. Experiments using both enzymes involved infusion of solutions into leaves. Preliminary experiments were performed to determine the best concentration and time of observation to distinguish resistant from susceptible leaves. For Worthington pectinase, there was significant leaf-to-leaf and plant-to-plant variability in response to the enzyme. Sigma pectinase first was used on a limited sampling (2 leaves/plant, 2 plants each of one susceptible and one resistant line). A concentration of about 25 units/ml, with observation at 3 hours after infusion, showed a mean of 2.25 lesions for susceptible leaves and 0.5 lesions for resistant. In a larger sample observed after 24 hours, resistant lesions totaled 23 while susceptible lesions equalled 26, showing a nearly equal enzyme response. These experiments demonstrate significant variability in the effects of infused pectinase. The only consistent observation was that higher pressure was required to infuse resistant leaves than susceptible.

The other enzyme used as an infusate was pectin lyase from *R. solani* (Dr. Bugbee, ARS, Fargo). In three experiments, a range of concentrations and periods of incubation were used. In two of the three experiments, there was no difference in response by susceptible and resistant leaves. The final experiment used the highest concentration of enzyme possible, 100,000 Relative Viscosity Units/ml. There was variability of response. There were 0.75 lesions/leaf for susceptible leaves, and 1.8 for resistant leaves. This variability might have been due to degradation of the enzyme over time, so another stored aliquot was tested for

activity against pollen. For this test, pollen germination was the same as for the fresh enzyme, indicating the enzyme was still active after 15 months of

frozen storage.

Anatomical differences between Rhizoctonia susceptible and resistant plants.

Infusion experiments performed in the in vitro assays suggested that there may be anatomical differences between Rhizoctonia susceptible and resistant plants in both leaves and roots. We had perceptibly more difficulty infusing both enzymes and water into leaves from resistant plants compared to susceptible plants. However, Ruppel (Phytopathology 63:123-126. 1973) found no anatomical differences in root tissue to account for resistance to Rhizoctonia fungal invasion. We conducted a series of investigations examining anatomical differences in leaves of susceptible and resistant plants to account for this infusion difficulty. These included comparison in three areas: the number of stomates/unit area, porometer experiments in laboratory and greenhouse to determine the degree that stomates were open or closed, and a comparison of the density of cells of the leaf spongy parenchyma.

To compare the number of stomates in Rhizoctonia susceptible and resistant plants, we used an ocular micrometer to define a unit area and counted stomates in epidermal peels. We compared three lines of resistant and three lines of susceptible plants. Three random leaf epidermal sections per leaf, with one leaf from each of two plants/line, were examined. Resistant lines had 1.2 times more stomates than susceptible. Since the difference in the number of stomates cannot account for the difficulty in infusing resistant plants, we conducted porometer experiments to determine the degree that stomates were open or closed. In the laboratory, using two lines each of susceptible and resistant lines, stomatal resistance levels of one leaf from three plants of each line were measured. Except for one plant of a resistant line, resistant plants had closed stomates and susceptible plants had open stomates. However, laboratory conditions involved low light intensity, not a normal condition. Also, presence of people in a closed environment increases carbon dioxide, which causes stomates to close. A second experiment, performed in the greenhouse to provide better conditions, showed apparently open stomates for all lines. The mostly closed stomates of resistant plants in the laboratory could account for the corresponding difficulty of infusing liquids, at least under laboratory conditions.

The final anatomical comparison involved a count of some dense cells visible in the spongy parenchyma of leaves. While they were present in all leaves, they appeared more numerous in resistant plants. Two experiments, one using plants 3 months old, and the second using induced plants, quantified the number of these dense cells per unit area. Each experiment used two lines each of susceptible and resistant plants. A single leaf from each of two plants per line was selected. Thin transverse slices of leaf tissue, mounted on microscope slides, were examined. We used an optical micrometer to define visually a unit area (a square, 100u on a side). The number of large dense cells present in each unit area, for four unit areas per leaf, were recorded, and the mean number of cells/square mm of leaf area was calculated. For both experiments, susceptible lines had an average of fewer dense bodies than the corresponding resistant

lines. However, in both experiments, FC709, highly resistant, was equal to that of susceptible lines, rather than other resistant lines. Hence, frequency of

dense cells in the leaf parenchyma is not a consistent indicator of resistance.

In addition to the studies on differences in leaves, we studied anatomical differences in Rhizoctonia susceptible and resistant roots. Preliminary experiments involved forcing a dye solution into the freshly cut crown surface of young roots. The dye generally penetrated further into susceptible root tissue than into resistant tissue. Therefore, we set up a controlled experiment and blind test using two lines each of susceptible and resistant roots. Four plants of each line, 3 months old, with approximately the same crown diameter were cut off and placed randomly into numbered humidity boxes. A different experimenter used a plastic syringe (no needle) filled with solution of neutral red dye. The tip of the syringe was embedded into the top cut crown surface and put under pressure for one second. (Infusion of a specific volume was not possible because of high resistance, and the amount infused was not measureable with the large syringe used. However, a dark red spot in the root showed that some infusion had taken place.) Three different spots were infused for each root.

Penetration was measured after all infusions were complete. Roots were sectioned and the depth of penetration of red color was recorded to the nearest 5 mm. The average penetration was 29.5 mm. One susceptible line (Monohikari) had significantly less dye penetration than the other susceptible and both resistant lines. Hence, infusability was not consistently different between susceptible and resistant roots.

Conclusions to be drawn from anatomical tests:

a. For diffusion tests involving leaves, the difficulty of infusing resistant plants cannot be explained by the number of stomates present, since resistant usually have more than susceptible plants. However, since resistant plants have closed stomates, at least under laboratory conditions, this could account for some of the difficulty in infusing liquids. Finally, the presence of a higher number of dense bodies in all of the resistant lines tested, except FC709, may also account for this difficulty of infusion. We intend further research on other resistant lines to clarify these apparent anatomical differences.

b. For diffusion tests involving roots, the neutral red infusions resulted in statistically significant differences between lines but no consistent difference between resistant and susceptible lines.

Challenge and selection of pollen for cool temperature tolerance.

We tested the hypothesis that pollen, able to survive and function at low temperature, would produce progeny that would develop more rapidly in cold soil. In our 1989 report, we discussed the two challenge methods: 1) a challenge of

pollen by low temperature during fertilization (four cycles of selection completed), and 2) the chilling injury of pollen during humidification, (four

pollen by low temperature during fertilization (four cycles of selection completed), and 2) the chilling injury of pollen during humidification, (four cycles now completed).

Mixed and inconsistent results were reported in 1989. One possible source of variation was the possibility that the low temperature challenge was not sufficiently lethal to eliminate nontolerant genotypes.

For the fourth cycle of selection using chilling injury of pollen during humidification, we tested a variety of techniques to effect greater lethality. The most effective method was exposure of pollen to 2 hours of humidification in a sealed humidity chamber at room temperature, followed by 2 hours of freezing (still in the sealed box) at -12 F. The pollen was immediately blown onto MS sib plants in greenhouse isolators, and the plants were allowed to set seed.

Testing for genetic change for these two populations was accomplished in two ways: pollen from selected populations was compared to original populations (sources) in percent germination and tube length at two test temperatures, 12 and 24 C. Secondly, seed resulting from these selections was tested for radicle elongation at the same two temperatures (see Table 1).

Comparisons of selected lines over 4 cycles of selection, versus controls, at 12° and 24° showed no indication of genetic change in ability to function at low temperature due to selection for chill-injury survival of pollen.

Table 1. Chill-injured pollen challenge and selection. Comparison of 4th cycle selected populations (1 and 2) to control (source populations).

	Pop 1 (901003)				Pop 2 (901004)			
	12C°		24C°		12C°		24C°	
	4th cy sel.	Control	4th cy sel.	Control	4th cy sel.	Control	4th cy sel.	Control
Pollen Tests								
% Germ	6.7	14.3	43.7	33.2	20.3	7.4	40.6	33.4
Tube Length (μ)	496.4	517.7	917.3	345.7	421.4	499.8	870.6	894.4
Seed Tests								
Radicle Elongation (mm)[a]	10.6	10.1	12.5	13.0	7.4	10.2	11.2	7.6
Radicle Elongation (mm)[b]	7.92	8.23	8.25	8.87	4.75*	2.6	6.02	3.8
	Pop 1				Pop 2			
Rate of radicle elongation (12/24)								
4th cy sel.[a]	87.5%				64.9%			
Control[a]	81.2%				143.4%			
4th cy sel.[b]	94.4%				76.4%			
Control[b]	92.4%				118.9%			

[a] Measurement of radicles which showed elongation.
[b] Mean of all radicles, elongating or not.
* Indicated significance at p = .05

Salinity challenge of pollen.

Techniques involved in the previous three salinity challenges of pollen were described in 1989. Seed resulting from the third challenge was planted in preparation for the fourth cycle of challenge. Plants bolted normally but with a high degree of male sterility. An O-type classification was done on the 33 plants. The pollen type is followed by the number of plants showing that type: 0, 9; 1, 15; 2, 5; 3, 1. Since plants did not produce enough pollen for a fourth cycle of selection, this experimental line has been abandoned. We have no explanation for the predominance of male sterile plants.

Cercosporin toxin effect.

Cercosporin (a toxin of *C. beticola)* was cultured and purified by Drs. Ruppel and Martin and supplied to us for experiments to determine if cercosporin could be used as an agent to assess degree of leaf spot resistance in sugarbeet plants. Using a range of heterogenous types from leaf spot susceptible through resistant, we tested cercosporin on pollen germination and K^+ leakage. Pollen germination was generally reduced for all lines, but the reduction did not relate to degree of resistance. Specific ion electrode measurements assessed K^+ leakage from pollen exposed to cercosporin. Leakage generally increased with cercosporin concentration, but the amount was not related to the degree of leaf spot resistance of the pollen donor plant.

Cercosporin also was used as a leaf infusate to assess our ability to differentiate between leaf spot susceptible (LSS) and leafspot resistant lines (LSR). In the first of two experiments, five different concentrations of cercosporin, ranging from 0-2.82 ug/ml, were infused into two lines of sugarbeet plants, one LSS and one LSR line. Five leaves (one/plant) were used for each line. When we assessed the effects, we could not clearly differentiate lines, since only two lesions appeared on the LSS plants at the highest concentration.

A field experiment was done by infusing 2.82 ug/ml of cercosporin into the leaves of eight lines which ranged from supersusceptible through resistant. The highest number of lesions was produced on the most susceptible line and the two resistant lines. Lesions were produced on a variety of lines. The leaf spot resistance of the line did not correlate with the lesions produced by the cercosporin infusion.

Challenge and selection of pollen for aluminum tolerance.

We are examining the possibility of using aluminum (in the form of aluminum sulfate) as an agent to select and challenge pollen for heavy metals tolerance. Preliminary experiments showed gametophytic challenge was possible (Figure 2).

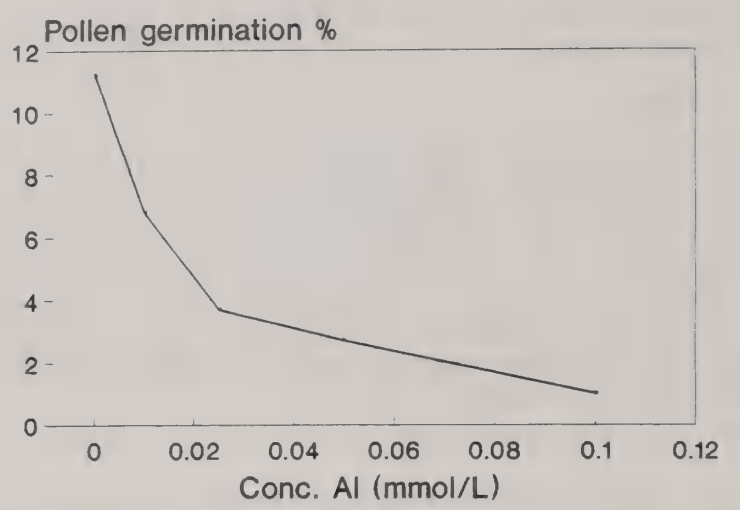


Fig. 2. Effect of Aluminum on sugarbeet pollen.

Our challenge method was applied to pollen from two populations segregating for male sterility. Both were assumed to contain genetic variance for aluminum tolerance, due to their parentage. The method included 1 hour of pollen exposure in a liquid medium containing Al^{+3} at 1 mmol concentration. After exposure, the pollen was "washed"; medium containing the pollen was centrifuged for 5 minutes at 5000 rpm to separate the pollen. The supernatant containing aluminum was withdrawn, the pollen resuspended in standard germination medium and recentrifuged. The supernatant was again removed, and the resultant pollen slurry used to pollinate flowers on male sterile segregants. About a dozen plants of each population were pollinated, including about 100 flowers/plant. Seed set occurred and the limited amount of resulting seed was all used to produce seedlings for the next cycle.

While not enough seed was produced in this first cycle to allow tests of the sporophyte for aluminum tolerance, we have developed methods for observing the effect of aluminum on seedlings to assess for genetic gain. While aluminum sulfate (30 mmol) retards radicle elongation or radicle length, it does not change the percent of seed that germinate. Our testing agent, aluminum sulfate, could affect seedlings in two ways; low pH (~3.2) and osmotic effect. A separate experiment compared aluminum sulfate with potassium sulfate (which has an osmotic influence only), and two water controls for their effect on radicle length. The acid pH of aluminum sulfate did not significantly effect radicle length (Figure 3). There was a significant osmotic effect of both aluminum and potassium sulfates (Figure 3). We intend to use these two salts on seed produced from the second cycle of selection to compare selected and control seedlings.

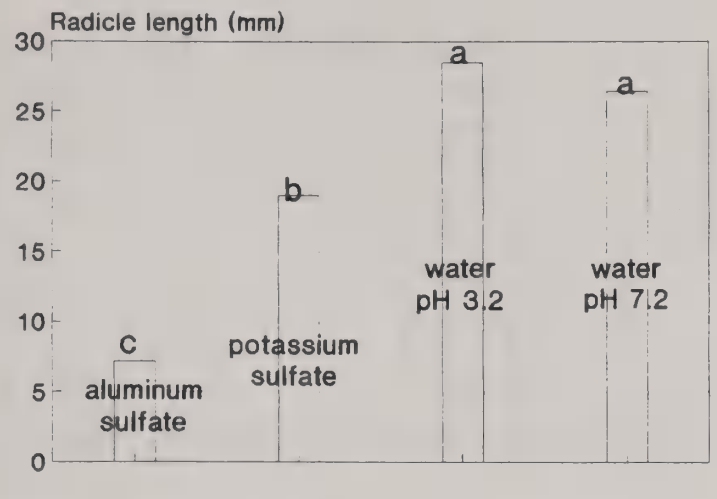


Fig. 3. Effect of aluminum (30 mmol) and pH on radicle length.

Long term pollen storage.

In July 1985, sugarbeet pollen was collected, desiccated to 9.3% moisture, divided into 10 12-mg samples, and cryopreserved in liquid nitrogen (LN). When samples have been removed, they were warmed at 24C for 30 minutes, then humidified for 30 minutes. In vitro pollen germination in liquid medium at collection, 6 months, 1, 2, 3, 4, and 5 years was measured, along with pollen tube length, viability stain reaction, seed set after pollination, and viability of seed (Table 2 and Figures 4-6). After pollen germination and viability tests, remnant pollen was blown onto flowering male-sterile plants. Seed set was the percentage of open flowers at pollination that produced an apparent seed. Viable seed was the percent of resultant seed that germinated.

Table 2. Tests of cryopreserved sugarbeet pollen.

Time in liquid N	In vitro germ. (%)	Tube length (μm)	FDA stained (%)	Seed set (%)	Viable seed (%)
Control (24 hrs)	32	-	-	-	-
0.5 yr	29	361	-	33	21
1 yr	34	275	-	-	9
2 yr	38	547	88	3	83
3 yr	22	491	77	12	92
4 yr	23	462	90	4	36
5 yr	9	707	48	64	12

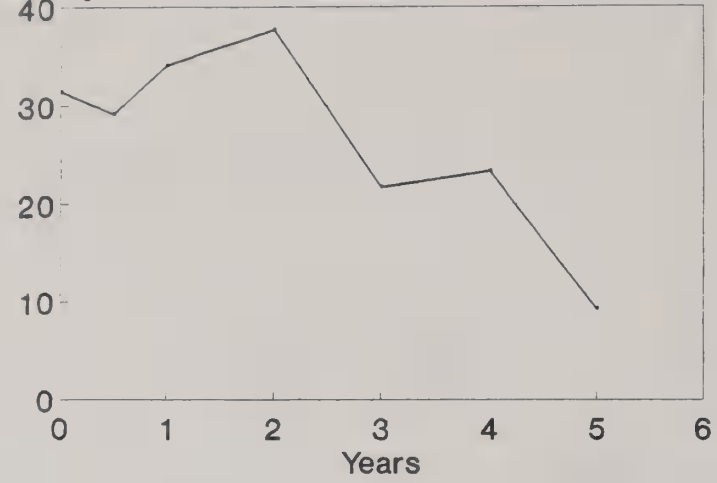


Fig. 4. Germination (in vitro) of cryopreserved sugarbeet pollen.

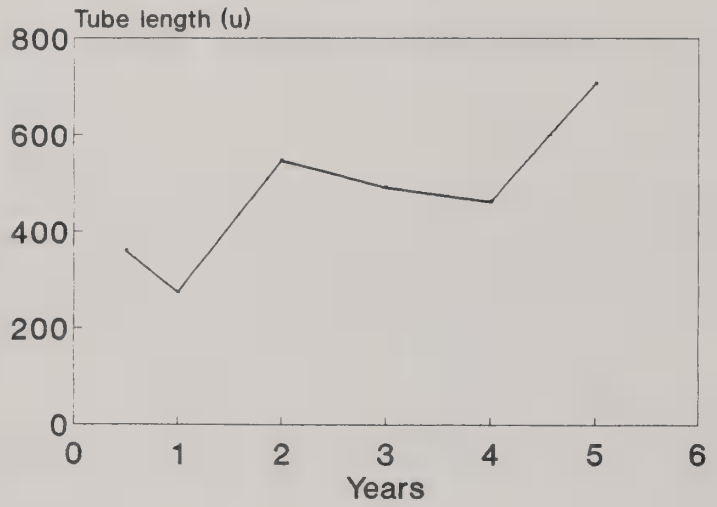


Fig. 5. Tube length of cryopreserved pollen.

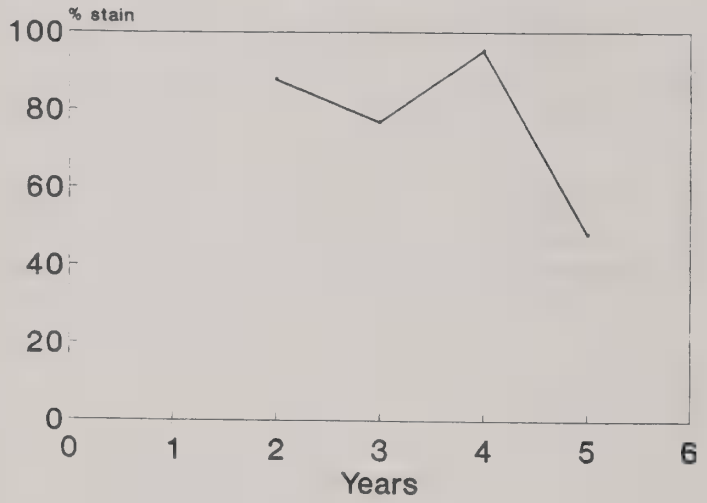


Fig. 6. FDA stain of cryopreserved pollen.

Pollen viability apparently declined from the third to the fifth year. The variability of seed set and seed quality (Table 2) should be viewed with caution. The quantity and quality of seed could be heavily influenced by the condition of the female flowers, environment at the time of fertilization, etc., and may not be due to reduced pollen quality. For our initial study, the two pollen samples that remain in LN will be tested in the future, perhaps at 10 and 15 years. A new 5-year cooperative project, initiated by the National Seed Storage Laboratory (USDA-ARS), will store sugarbeet pollen in LN, and will study the interaction between storage moisture, time of storage, and level of sucrose in the germination medium. The experiment recently commenced will better define variables in factors influencing pollen quality. This will allow further assessment of LN storage as a technique for germplasm preservation. The technique also may be useful for breeders to preserve pollen for later use in a breeding program after progeny tests or other breeding assessments have been completed.

A test done after 5 1/2 years of LN storage produced a germination of 9.2%, using our standard medium with 32% sucrose. However, in a 20% sucrose concentration, this germination was 20%. This may show that pollen stored for long periods requires a medium with a lower osmolality than does fresh pollen.

Heat challenge of pollen.

We are beginning a project which is the reverse of the project in Section 3; challenge and selection of pollen for high temperature tolerance. Sugarbeet plants able to tolerate high temperatures or dry conditions would have a productivity advantage. We will select pollen able to survive and function at high temperatures. These pollen may be able to produce progeny able to survive periods of hot or dry conditions.

Humidification is important in allowing pollen to germinate. Therefore, preliminary experiments studied the effect of humid versus dry heat in the survivability of pollen. Results were erratic, apparently because the effect of a heated humid environment depends upon the relative quantity of pollen available. "Humid heating" as a treatment for selection is unacceptable. Subsequent experiments were conducted using a range of times and temperature regimes. A standard "dry heat" treatment was developed, and will be used on two source populations to select pollen for tolerance to hot/dry conditions.

The standard heat treatment of pollen uses a lab oven to generate a temperature of 110 F. Pollen are pre-humidified for one hour to assure a standard initial humidity level, then are left in the oven with no humidification for five hours. About 5% of the pollen survive this treatment, and will be used to fertilize the male steriles. After first-cycle seed is produced, they will be used for the second cycle and will be tested for heat tolerance.

HPLC analysis of sugarbeet pollen sugars and correlation with root sucrose.

In cooperation with Judy Narum, BSDF chemist in our lab, we developed methods for pollen sugar analysis by High Performance Liquid Chromatography (HPLC). We tested a variety of methods for sample preparation, including refluxing in methanol and sonication in three media: extraction in 80% methanol, distilled water at room

temperature, and distilled water at 60 C. The latter two methods did not extract the full quantity of the sugars present, and resulted in degradation of more sucrose into fructose and glucose. The best method of sample preparation of pollen involves extraction in 80% methanol with sonication, vacuum evaporation, filtration, and finally, HPLC analysis. At this time we have analyzed 12 different samples representing six genetically different lines. In this preliminary study, the sucrose content of pollen and mature field grown roots were not significantly correlated.

To our knowledge, this is the first time that beet pollen has been analyzed for sugars. In our experiment, the sucrose concentrations of pollen ranged from 9.0 to 10.8% (fresh weight basis) with a mean of 9.8%. Concentrations of fructose and glucose were low, both were about 0.1%. Betaine measured in the same experiment was 1.6% of fresh weight.

Kanamycin tolerance of pollen.

In our 1987 Sugarbeet Research Report, we reported the effect of increasing concentrations of kanamycin on pollen survival. Pollen survival dropped from 100% to 0% across concentrations of kanamycin of 0-40 ug/ml. In studying more genotypes this year, we compared the survival of pollen (percent germination) from 8 lines of sugarbeets at three concentrations of kanamycin: 0, 4, and 8 ug/ml. There was significant entry x treatment interaction. At 8 ug, two entries were relatively kanamycin tolerant (23% survival) and the other six were relatively sensitive (5% survival). This may limit the usefulness of kanamycin tolerance as a genetic characteristic in genetic transformation experiments.

SUGARBEET RESEARCH

1990 Report

SECTION D

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Colorado State University Experiment Station
Minn-Dak Sugar Cooperative
Minnesota Agricultural Experiment Station
Sugarbeet Research and Education Board of
Minnesota and North Dakota

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CONTENTS

Abstracts of Papers Presented, Published, or Approved for Publication and Germplasm Registrations

Bugbee, W. M. 1990. Purification and characteristics of pectin lyase from *Rhizoctonia solani*. *Physiological and Molecular Plant Pathology* 36:15-25.

> Pectin lyase was the predominant pectolytic enzyme produced by an anastomosis group 2-2 strain of *Rhizoctonia solani* both in culture and in infected sugarbeet crowns. Sugarbeet root cell walls were used as the carbon source in broth still culture. Cell walls from crowns induced more pectin lyase than cell walls from hypocotyl or root. Also, the yield of pectin lyase was higher from infected crown than from infected hypocotyl or root tissue. Rotted crown tissue had a pH of over 7, which was favorable for pectin lyase activity. Rotted root tissue, with a pH below 6, was not as favorable for pectin lyase activity. Healthy tissue had a pH of 6.5 $\pm$ 0.3. Pectin lyase was purified by affinity batch chromatography on cross-linked sodium polypectate followed by gel permeation on an agarose-based gel. Pectin lyase interacted with the agarose-based gel and eluted at or near the bed volume which resulted in a final effective purification. The molecular weight of pectin lyase from culture was determined as 35 kDa. The pI was 10.1. The purified enzyme caused wilt when injected into *Rhizoctonia*-susceptible sugarbeet plants, but not when injected into resistant plants.

Bugbee, W. M. 1990. Chapter 15. Storage. *In* Sugarbeet. Chapman and Hall, London (in press). (Book Chapter)

> Loss of sucrose from stored sugarbeets is caused by factors that alter the physiological state of the root, microbial activity and mechanical damage to the root. These factors elevate the root's respiration rate to induce excessive metabolism of sucrose. Methods that have been used to reduce the respiration rate and storage losses are reviewed in this storage chapter of a textbook on sugarbeet. These methods include proper fertilization of the crop during the growing season, application of chemicals to the harvested root to retard respiration or microbial activity, coverings to control pile environment, ventilation to lower root temperature, temporary and permanent storage structures, modified machinery to reduce mechanical damage, frozen storage, pile-splitting, and breeding for lower respiration and resistance to storage rot pathogens.

Bugbee, W. M. 1990. An inhibitor of pectin lyase from sugar beet. *Phytopathology* 78:1590. (Abstract)

> Pectin lyase (PNL) was the major pectolytic enzyme produced by *Rhizoctonia solani* AG 2-2 in culture and in infected sugarbeet crowns and roots. A constitutive inhibitor of PNL (PNLi) was extracted from healthy sugarbeet roots. The PNLi was purified by cation exchange, affinity and gel filtration

chromatography. The PNLi is a protein with a molecular weight estimated at 43 kD. Inhibitory activity was most effective at pH 6.5. The average content of PNLi for crown, hypocotyl and root tissue was 40% higher in a root rot resistant germplasm line than in a susceptible cultivar and was higher in the root than the crown of the resistant cultivar. PNLi partially protected cells from damage caused by PNL. Growth of *R. solani* in liquid culture was not inhibited by PNLi.

Bugbee, W. M. 1991. Purification and properties of a pectin lyase inhibitor from sugar beet. *Physiological and Molecular Plant Pathology* (submitted for publication).

A constitutive glycoprotein inhibitor of pectin lyase (PNL) was purified by affinity chromatography on a cyanogen bromide activated gel to which pectin lyase was coupled. Further purification was done by size exclusion chromatography where four fractions with estimated masses of 28, 15, 8 and 3 kD were resolved. Subunits within each fraction were resolved with polyacrylamide gel electrophoresis in sodium dodecyl sulfate. The inhibitor was in higher concentrations in a root rot resistant germplasm than in a susceptible cultivar and also higher in root than in hypocotyl or crown tissue. The inhibitor gave partial protection to cell damage caused by PNL. The inhibitor was unequally effective against PNL from *Rhizoctonia solani, Phoma betae* and *Aspergillus japonicus*.

Campbell, L. G. 1990. Effect of temperature on sugarbeet seedling emergence. *Agronomy Abstracts* p. 138.

Poor stand establishment is a frequent problem in sugarbeet (*Beta vulgaris* L.) production. Percent emergence, days to 50% emergence, and two indices of emergence speed were measured at temperatures between 10 and 25° C on a thermogradient plate. Percent emergence 14 days after planting increased rapidly between 10 and 16° C. Above 22° C there was no increase in emergence percent. Days to 50% emergence decreased sharply as temperatures increased and reached a minimum at 25° C. No significant differences in emergence percent or rate of emergence were found among the 15 commercial hybrids examined. Significant year by hybrid interactions suggested that seedlots differed in emergence characteristics. Relating the above results to soil temperatures should be beneficial in determining optimum planting date.

Campbell, L. G. 1991. Registration of four sugarbeet germplasms selected from the NC-7 *Beta* collection. *Crop Science* (in press).

Five sugarbeet germplasms, F1011 - F1014, were developed by the USDA-ARS and the North Dakota Agricultural Experiment Station. All have relatively high sucrose concentration and all were selected from the USDA-ARS *Beta* germplasm collection (NC-7) maintained at Ames, Iowa. F1010 resulted from five cycles of selection based upon both family and individual root sucrose concentration.

These germplasms make readily available a portion of the genetic diversity within the USDA NC-7 collection. They are intended to provide a unique genetic source for the development of populations and parental lines with improved agronomic performance.

Campbell, L. G. and J. W. Enz. 1991. Temperature effects on sugarbeet seedling emergence. *Agronomy Journal* (submitted for publication).

Poor stand establishment is a frequent problem in sugarbeet (*Beta vulgaris*) production. Percent emergence, days to 50% emergence, and two indices of emergence speed were measured at temperatures between 10 and 25 C on a thermogradient plate. Percent emergence 14 days after planting increased rapidly between 10 and 16 C. Above 22 C there was no increase in emergence percent. Days to 50% emergence decreased sharply as temperature increased and reached a minimum at 25 C. No significant differences in emergence percent or rate of emergence were found among the 14 commercial hybrids examined. Significant year by hybrid interactions suggested that seedlots differed in emergence characteristics. Relating the above results to soil temperatures should be beneficial in determining optimum planting date.

Doney, D. L. 1990. Selection for green leaf duration in sugarbeet. *Agronomy Abstracts* p. 86.

Sucrose, a storage component of the root, is the economic product in sugarbeet. Theoretically, the longer the leaves remain photosynthetically active the more photosynthate is supplied to the root and should relate to sucrose yield. Leaf growth and green leaf duration (initiation to senescence) of the first eight leaves were measured in genetically uniform and highly heterozygous sugarbeet populations. Daily measurements identified the days after planting that the first eight leaves reached the 1 cm, 5 cm, and 20 cm lengths and/or death. Significant genetic variation was obtained for the green leaf duration of the first eight leaves. Correlations between root yield and green leaf duration were significant for the first true leaves only. One selection cycle for green leaf duration of the first true leaves extended their life span (initiation to senescence) for an additional two days. Green leaf duration in sugarbeet is genetically controlled and can be altered by appropriate selection procedures.

Doney, D. L. and J. C. Theurer. 1990. Osmolality of L19 type sugarbeet germplasm. *Journal of Sugar Beet Research* (in press).

Since sucrose is the major soluble particle in mature sugarbeet root cells, differences in sucrose concentration should correlate with osmotic concentration. Osmotic concentrations were measured from frozen root tissue of 5-wk-old seedlings with a vapor pressure osmometer. Tests were conducted under different levels of N fertility, drought, day length and temperature and for a wide range

of commercial hybrids, experimental hybrids and inbreds. Osmotic concentrations in sugarbeet seedlings were not affected by different levels of N fertility, drought and temperature even though plant growth was significantly affected by these parameters. Correlations between seedling osmotic concentration and sucrose concentration at harvest were significant in two experiments and non-significant in two others. Tests giving significant correlations were largely due to the high sugar L19 inbred or hybrids with L19 inbred as a parent. This inbred consistently gave significantly higher osmotic concentrations than the other cultivars.

Smith, G. A. USDA Sugarbeet research in the USA. Proc. 53rd International Congress of the IIRB, Brussels, Belgium, February 12-14, 1990.

Public research in the USA is conducted by the USDA at Fargo, North Dakota; Fort Collins, Colorado; Salinas, California; East Lansing, Michigan; and Beltsville, Maryland. Significant research efforts are being placed on the diseases caused by Cercospora, Rhizoctonia, nematodes and the virus diseases of Rhizomania, curly top and virus yellows. The development of a biopesticide for use against insects currently controlled by chemicals is a major new area of research. Transformation utilizing genes from the bacteria *Bacillus thuringiensis* is the major approach.

Smith, G. A. and D. R. Buxton. 1991. Temperate zone sweet sorghum ethanol production potential. *Crop Science* (submitted for publication).

This study was prompted by response to the focus of public attention on alcohol fuels as an aid toward reducing pollution, dependence on foreign oil, and crop surpluses. Four sweet sorghum [*Sorghum bicolor* (L.) Moench] cultivars were tested for fermentable sugar production potential under irrigated and non-irrigated conditions with 0, 84, and 186 Kg ha^{-1} of nitrogen fertilizer at two temperate zone locations (40.8° and 42° N latitude). Locations chosen represented a typical temperate zone irrigated location and a typical corn belt natural rainfall area. Average ethanol (EtOH) yields for the 2-yr study were above 3100 L ha^{-1} and ranged up to 5235 L ha^{-1}. The irrigated location produced more gross green weight (89.8 Mg ha^{-1}) as compared to the natural rainfall location (65.0 Mg ha^{-1}), but total sugar yield and theoretical EtOH were not significantly different. Added nitrogen fertilizer had little discernable effect at either location or in either year. Results of this research emphasize the potential of sweet sorghum as an alternative energy crop to help insulate ethanol production from the effects of shifts in corn prices.

Smith, G. A. and J. D. Eide. 1990. Use of *Bacillus thuringiensis* endotoxin gene for insect control in sugarbeet. *Agronomy Abstracts* p. 110.

Bacillus thuringiensis is being investigated for possible use as a biopesticide to control sugarbeet root maggot (*Tetanops myopaeformis*). Methods of colonization are being examined. Ten ml of *B. thuringiensis* (0.5×10^6, 1.0×10^6, or 10.0×10^6 ml^{-1}) was applied to flowering sugarbeet by aspiration. Seed was collected, surface sterilized, and ground with a mortar and pestle. Small quantities of *B. thuringiensis* were detected in the seed. The naturally occurring endophyte *Bacillus subtilis* is being examined as a suitable organism for transfer and expression of the endotoxin from *B. thuringiensis*. Another method of application explored includes soil drenching of sugarbeet seedlings with 20 ml of *B. subtilis* (10.0×10^6 ml^{-1}). Surface sterilized shoots or roots from 7- to 9-week-old sugarbeets were ground and analyzed for *B. subtilis*. No *B. subtilis* was found in 5 to 7 g of leaves. We are examining the colonization patterns of *B. subtilis* in the roots and seed of soil drenched sugarbeet seedlings. Other nonpathogenic endophytes have been isolated from roots or the sugarbeet rhizosphere. These bacteria will be screened for suitability as a host for the endotoxin from *B. thuringiensis*. A suitable vector pSE3 isolated from *B. subtilis* will be used for integration of the endotoxin gene.

Papers Published Since Abstracted in Previous Report

BUGBEE, W. M. 1990. Rhizoctonia root rot research. *Sugarbeet Research and Extension Reports* 20:131-133. (Industry Publication)

BUGBEE, W. M. and L. G. CAMPBELL. 1990. Combined resistance in sugarbeet to *Rhizoctonia solani, Phoma betae*, and *Botrytis cinerea. Plant Disease* 74:353-355.

CAMPBELL, L. G. 1990. Sugarbeet germplasm selected from the USDA collection. *North Dakota Farm Research* 47(9):32-34. (Popular Publication)

CAMPBELL, L. G., A. W. ANDERSON, and K. A. PRODOEHL. 1990. Selection for resistance to sugarbeet root maggot. *Sugarbeet Research and Extension Reports* 20:108-109. (Industry Publication)

DONEY, D. L. 1990. The value of wild beets. *Sugarbeet Research and Extension Reports* 20:177-178. (Industry Publication)

DONEY, D. L. 1990. Wild beet genes. *The Sugar Producer*, Summer 1990: 10-11. (Popular Publication)

DONEY, D. L. and E. D. WHITNEY. 1990. Genetic enhancement in *Beta* for disease resistance using wild relatives: A strong case for the value of genetic conservation. *Economic Botany* 44(4):445-451.

DONEY, D. L., E. D. WHITNEY, J. TERRY, L. FRESE, and P. FITZGERALD. 1990. The distribution and dispersal of *Beta vulgaris* L. ssp. *maritima* Thell. germplasm in England, Wales, and Ireland. *Journal of Sugar Beet Research* 27:29-37.

GALATOWITSCH, M. W. and G. A. SMITH. 1990. Regeneration from unfertilized ovule callus of sugarbeet (*Beta vulgaris* L.). *Canadian Journal of Plant Science* 70:83-89.

MOSER, H. S., G. A. SMITH, and S. S. MARTIN. 1990. Sporophytic and gametophytic response of sugarbeet to two pathotoxins. *Crop Science* 30:1-6.

SEILER, G. J. and D. L. DONEY. 1990. Wild sugarbeet germplasm explorations in Europe. *Sugarbeet Research and Extension Reports* 20:179-183. (Industry Publication)

SMITH, G. A. and J. D. EIDE. 1990. Research to develop a biopesticide for control of serious sugarbeet insects pests. *Sugarbeet Research and Extension Reports* 20:106-107.

CERCOSPORA RESISTANCE BREEDING AND RELATED RESEARCH
BSDF Project 600

G. A. Smith

1990 CERCOSPORA BREEDING NURSERY.--Evaluations of breeding lines were carried out at the ARS nursery located on CSU land in Fort Collins. The nursery was planted April 20 and inoculated on June 29 and July 6. Disease evaluations were conducted August 16, 21, and 28 and on September 4. The mean leaf spot ratings of the resistant and susceptible checks on September 4 were 4.75 and 7.25, respectively. These values compared with 3.25 and 6.50 for resistant and susceptible checks, respectively, in 1989. The epidemic developed relatively early as indicated by the susceptible check which rated 4.50 on August 16.

A new line which will be designated FC 907 was sent to Oregon for seed increase in anticipation of release in 1992-93. This line is a Cercospora resistant multigerm pollinator developed via backcrossing with FC 607 as the recurrent parent. The multigerm trait is from the nonrecurrent parent FC 701/4. In several years of testing in our leaf spot nursery, the line has shown leaf spot resistance equal to or slightly better than the long term resistant check (see entry number 1581).

Sixty-four entries were included in the Cercospora nursery and 34 in the Curly Top nursery in 1990 (Table 1). Of these 64 entries, 31 (48%) equaled or surpassed the resistant check for leaf spot resistance on September 4. Of the 34 entries in the Curly Top nursery, 11 (32%) had ratings of less than 5.

Table 1. Leaf spot and Curly Top ratings of breeding lines at Fort Collins, CO and Kimberly, ID, respectively, 1990.

Entry No.	Seed No.	Description/Pedigree	Ratings* Leaf Spot	Curly Top
1542	871028HO3	FC 607 CMS X FC 502/3 T.O.	3.25	5.5
1543	871032HO3	FC 607 CMS X FC 506 T.O.	4.75	7.0
1544	871034HO2	FC 502 CMX X FC 607 T.O.	4.75	5.6
1545	871034HO6	652016 CMS X FC 607 T.O.	4.75	4.7
1546	871034HO7	662119HO1 CMS X FC 607 T.O.	4.50	4.1
1547	871038HO	FC609 T.O.	5.00	4.8
1548	871038HO1	FC 609 CMS	4.75	5.2
1549	861016HO	FC 607 (4X) T.O. (C3)	4.25	4.8
1550	861016HO1	FC 607 CMS (4X) (C3)	3.50	5.7
1551	861019HO2	FC 506 CMS X FC 607 T.O.	3.75	6.0
1552	861019HO4	761036HO1 CMS X FC 607 T.O.	3.50	4.8
1553	861020HO2	FC 607 CMS X 662119HO	5.25	4.8
1554	861025HO4	FC 607 CMS X 64010 T.O.	4.75	4.7
1555	881018HO3	FC 506 CMS, mm X FC 502/2, T.O. mm	4.75	
1556	881019H3	FC 607 CMS, mm X FC 901, mm	6.50	4.7
1557	892018H2	FC 606 T.O. X B2007	4.75	
1558	881020HO4	652016HO1 CMS, mm X FC 603 T.O. mm	3.50	
1559	881020HO5	FC 607 CMS, mm X FC 603 T.O. mm	3.50	

Entry No.	Seed No.	Description/Pedigree	Ratings* Leaf Spot	Curly Top
1560	821052	Yellow Leaf Mutant	7.25	
1561	881021HO2	FC 506 CMS, mm X FC 502 T.O. mm	3.50	
1562	881021HO3	FC 506 CMS, mm X FC 502 T.O. mm	4.00	
1563	881022HO4	FC 609 CMS, mm X FC 607 T.O. mm	3.75	
1564	881022HO5	761036HO1 CMS, mm X FC 607 T.O. mm	3.50	
1565	881022HO6	652016HO1 CMS, mm X FC 607 T.O. mm	3.75	
1566	881033	FC 702/7	6.50	
1567	892001H2	FC606 cms, mm X L19	5.75	5.7
1568	892001H3	FC607 cms, mm X L19	6.75	5.8
1569	892003HO2	FC607 cms, mm X FC609 T.O.	4.50	
1570	892004HO2	FC607 cms, mm X FC502/3 T.O. mm	4.00	5.1
1571	892005H2	(FC506 cms X FC 607 T.O.) X H8277	6.00	5.8
1572	892005H3	(FC607 cms X 662119HO) X H8277	6.50	6.3
1573	892005H4	(FC607 cms X FC502/3 T.O.) X H8277	6.25	
1574	892005H5	(FC607 cms X FC506 T.O.) X H8277	6.00	
1575	892005H6	(FC609 cms X H8277)	6.00	
1576	892007H2	(FC506 cms X FC 607 T.O.) X B2007	5.25	6.8
1577	892007H3	(FC607 cms X 662119HO) X B2007	5.75	6.3
1578	892007H4	(FC607 cms X FC502/3 T.O.) X B2007	5.75	6.1
1579	892007H5	(FC607 cms X FC506 T.O.) X B2007	5.50	6.3
1580	892007H6	(FC609 cms X B2007)	6.00	
1581	892008H2	(FC607 T.O., rr, mm X FC701/4 97% R_, MM) X FC607 T.O., rr, mm) BC4	4.75	7.0
1582	892009H2	(FC606 T.O., rr, mm X FC701/4 97% R_, MM) X FC607 T.O., rr, mm) BC4	6.75	4.8
1583	892010H	H8277	6.25	
1584	892010H2	FC607 T.O. X H8277	4.50	5.8
1585	892011H	H8277	6.75	
1586	892011H2	FC609 T.O. X H8277	5.50	
1588	892013H	A200	5.50	5.0
1589	892013H2	FC607 T.O. X A200	4.00	
1590	892014H	A200 X FC609 T.O.	6.75	4.8
1591	892014H2	FC609 T.O. X A200	4.75	
1593	892016H	B2007	6.75	4.8
1594	892016H2	FC607 T.O. X B2007	4.50	
1597	892021H2	(FC504 cms X FC502/2, mm) SP6322-0, LSR, increase	4.50	
1598	892021H	SP6322-0, MM, R_, rr increase	4.75	
1599	892018	Syn Check, LSS, increase, R_, rr	7.25	
1600	AF89-227	NS-4, 2N, mm, Fert. pop. Yugoslavia	8.00	
1601	892017H2	FC609 T.O. X B2007	4.25	
1602	AF90-1	Rhizor, 2N, MM, LSR, Italy	5.00	
1603	AF90-2	F1004, M_, R_,rr, Storage Rot Res.	6.00	
1604	AF90-3	F1005, M_, rr, Storage Rot Res.	6.75	
1605	AF90-4	F1009, M_, R_,rr, Storage Rot Res.	7.25	
1606	AF90-5	F1010, M_, R_,rr, Storage Rot Res.	7.75	
1607	801123HO	FC607 T.O. Reselected	4.25	
1608	821051H2	FC(504 X 502/2) X SP6332-0, LSR Check	4.75	
1609	891018	Syn Check, LSS Check	7.25	
1610		US 33, CTS Check		5.2
1611		US 41, CTR Check		4.2

*Ratings based on 0 to 10 scale, with 0 = no symptoms and 10 = complete defoliation for leaf spot and death for Curly Top.

LEAF SPOT EVALUATION OF U.S.-YUGOSLAVIAN CROSSES.--Crosses involving the most Cercospora-resistant lines from our breeding program were crossed with lines from the Yugoslavian research station at Novi Sad, Yugoslavia. This was part of a five-year PL-480 project.

Included in Table 2 are reading dates from 1990 and from 1989. Both dates are included to illustrate that certain of these entries would have been classified as more leaf spot resistant in 1989, when in reality they are not that resistant. One should be cautious about reporting leaf spot ratings without reference to susceptible and resistant checks. The lines from Yugoslavia which were used as both males and females in the crosses purportedly have resistance to leaf spot. In only one case did the hybrids display more resistance (lower reading) than the FC parental component line. Four of the entries (entry numbers 1531, 1532, 1534, and 1535) were triploids using tetraploid versions of FC 606 and FC 607 as pollinators. These were not significantly different from crosses involving some of the same pollinators as diploids.

Under the more severe epidemic of 1990, none of the hybrids equaled the reading of the leaf spot resistant check; however, four of the hybrids were not significantly different (readings = 4.00 or 4.17). All of the entries' leaf spot ratings were lower (more resistant) than the susceptible check.

Two hybrids with the same parental component which had been synthesized in 1987 and 1988 also were compared in this test (entries 1520, 1521, 1538, and 1539). Slight differences in absolute values were noted, but there were no entry X year interactions.

This test once again demonstrates that maximum resistance to leaf spot is achieved in hybrids where both parental components have been developed for Cercospora resistance. Crosses involving resistance in only one parent are always less resistant than the resistant parent (a fact which we have observed repeatedly).

Table 2. Mean leaf spot ratings of U.S.-Yugoslavia crosses using 2X and 4X U.S. pollinators. (PL-480 Project)

Entry No.	Seed No.	Description/Pedigree*	Leaf Spot Ratings** Aug 28 1990	Sept 4 1990	Sept 5 1989
1520	881040H2	FC 607 CMS, 2X, X NS-2485/85, 2X	4.00	4.67	3.50
1521	881040H3	FC 606 CMS, 2X, X NS-2485/85, 2X	3.50	4.17	3.00
1522	881040H4	FC 502 CMS, 2X, X NS-2485/85, 2X	3.67	4.83	2.75
1523	871038HO1	FC 609 CMS	3.50	4.17	3.25
1524	A79-67	FC 607 (2X), T.O.	3.50	3.67	3.00
1525	871003HO2	NS-6A84, 2X, CMS X FC 607 (2X), T.O.	4.17	4.50	3.25
1526	871003HO4	NS-MS100, 2X, CMS X FC 607 (2X), T.O.	4.00	4.83	3.00
1527	781035HO	FC 606 (2X), CMS	4.00	5.17	3.25
1528	871004HO2	NS6A84, 2X, CMS X FC 606 (2X), T.O.	4.50	4.67	3.25
1529	871004HO5	NS-62MS, 2X, CMS X FC 606 (2X), T.O.	4.00	5.17	3.00
1530	841042HO	FC 606 (4X), T.O.	3.67	4.17	3.25
1531	871005HO2	NS-6A84, 2X, CMS X FC 606 (4X), T.O.	4.17	5.00	3.50
1532	871005HO5	NS-62MS, 2X, CMS X FC 606 (4X), T.O.	4.67	5.33	4.00

Entry No.	Seed No.	Description/Pedigree*	Leaf Spot Ratings** Aug 28 1990	Sept 4 1990	Sept 5 1989
1533	841040HO	FC 607 (4X), T.O.	3.67	3.83	3.25
1534	871006HO2	NS-6A84, 2X, CMS X FC 607 (4X), T.O.	3.50	4.17	3.75
1535	871006HO5	NS-62MS, 2X, CMS X FC 607 (4X), T.O.	3.83	4.17	3.25
1536	A86-43	NS-F-658, 2X, MM	4.67	5.83	3.50
1537	A86-44	NS-2485/85, 2X, MM	4.17	5.33	3.25
1538	871008H2	FC 607 CMS, 2X, X NS-2485/85, 2X	3.67	4.33	3.25
1539	871008H3	FC 606 CMS, 2X, X NS-2485/85, 2X	3.33	4.00	3.00
1540	821051H2	LSR CHECK	3.50	3.67	3.00
1541	891018	LSS CHECK	6.67	7.00	6.00

*All entries are monogerm (mm) except as indicated.

**Maximum leaf spot rating received by a given entry, across replications and date of reading. Test conducted at Fort Collins, Colorado.

IN VITRO SELECTION, REGENERATION, AND BIOPESTICIDE DEVELOPMENT RESEARCH
BSDF Project 601

G. A. Smith and J. D. Eide

IN VITRO SELECTION FOR *CERCOSPORA* RESISTANCE.--Cell suspensions from FC 607 T.O., FC 609 T.O., Rel 1 and ovule-derived callus were placed on overlay plates containing 1 μg ml^{-1} rose bengal or paraquat. These plates allow the slow diffusion of the toxin into the growth media. The actively growing suspension cultures were subjected to 1 μg or 10 μg ml^{-1} rose bengal or paraquat for 6 or 18 hours. Rinsed cells were placed on shoot producing media. Alternatively, ovule-derived callus was placed on overlay plates containing 1 μg or 10 μg ml^{-1} rose bengal or paraquat for 18 days. The calli were then placed on shoot producing media. Leaf disks and petiole-derived callus was examined for regeneration. Media salts, hormones, and vitamins were varied to determine the optimal regeneration system. No regeneration has occurred using this selection regime. The cell suspension and overlay system are being optimized for regenerative capacity.

ASSAY OF *BACILLUS THURINGIENSIS* STRAIN FOR BIOPESTICIDE ACTIVITY AGAINST SUGARBEET ROOT MAGGOT (*TETANOPS MYOPAEFORMIS*).--Two strains of *Bacillus thuringiensis (Bt)* were investigated for biopesticide activity against sugarbeet root maggot (Diptera: *Tetanops myopaeformis*). The strains, *B. thuringiensis israelensis* and *B. thuringiensis galleriae*, are known to be active against certain dipteran species. These strains were grown in nutrient broth at 37°C and agitated at 200 rpm. Bacterial growth rate curves were determined by light absorbance readings taken at 600 nm (Figures 1 and 2).

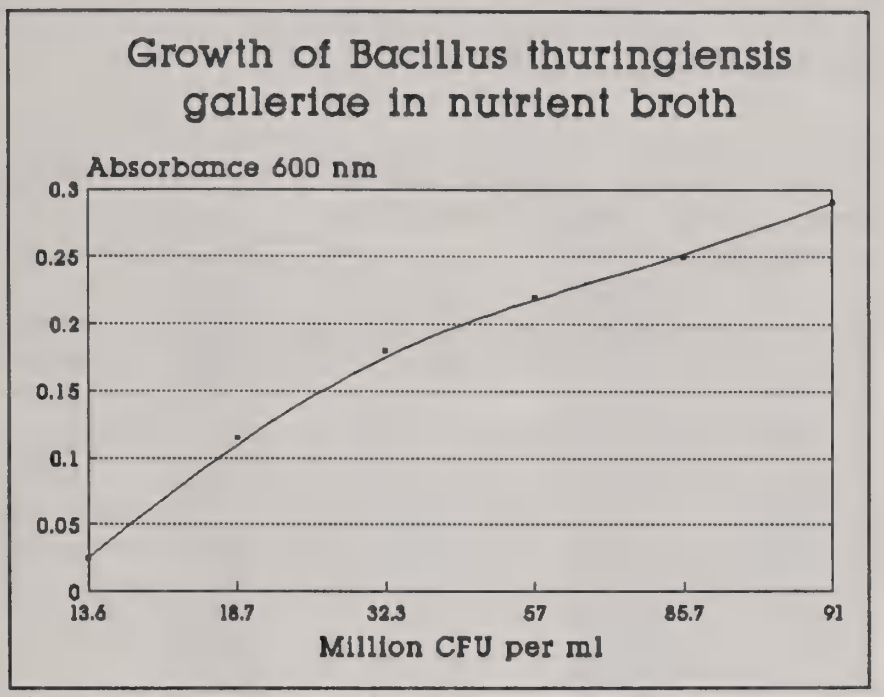

Figure 1. Growth of *Bacillus thuringiensis galleriae* in nutrient broth.

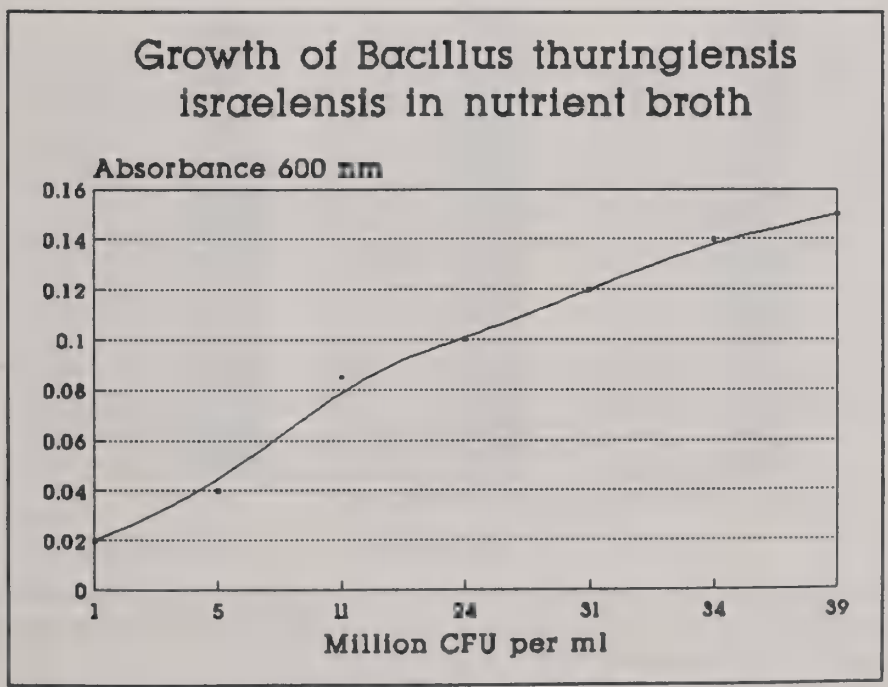

Figure 2. Growth of *Bacillus thuringiensis israelensis* in nutrient broth.

To provide spray treatments for field studies, bacterial cultures were pelleted and suspended in 50 mM potassium phosphate buffer. Dilutions were made in the field to 10 million colony forming units (CFU) ml^{-1}.

Replicated field plots of two cultivars, Monohikari and L8 (a maggot tolerant line) were sprayed with aqueous solutions containing 10 million CFU/ml of *B. thuringiensis israelensis*, *B. thuringiensis galleriae*, or a water control. The application rate was 222.7 gpa. Four-row plots were sprayed each week for five weeks.

Stand counts were taken 41, 48 and 81 days after planting. Damage ratings were based on a visual assessment using a scale of 1 to 5 where 1 = no damage and 5 = severe damage.

Stand counts were virtually unchanged from 41 days to the final stand counts at 81 days after planting. Slight variation in plant numbers was found in the water spray check plots at 81 days (Figure 3). Differences in stand counts between Monohikari and L8 were only found at 41 days after planting, when Monohikari had significantly higher plant stands than L8 (Figure 4). This is most likely attributed to the inherent vigor of a commercial hybrid compared to a close-bred line.

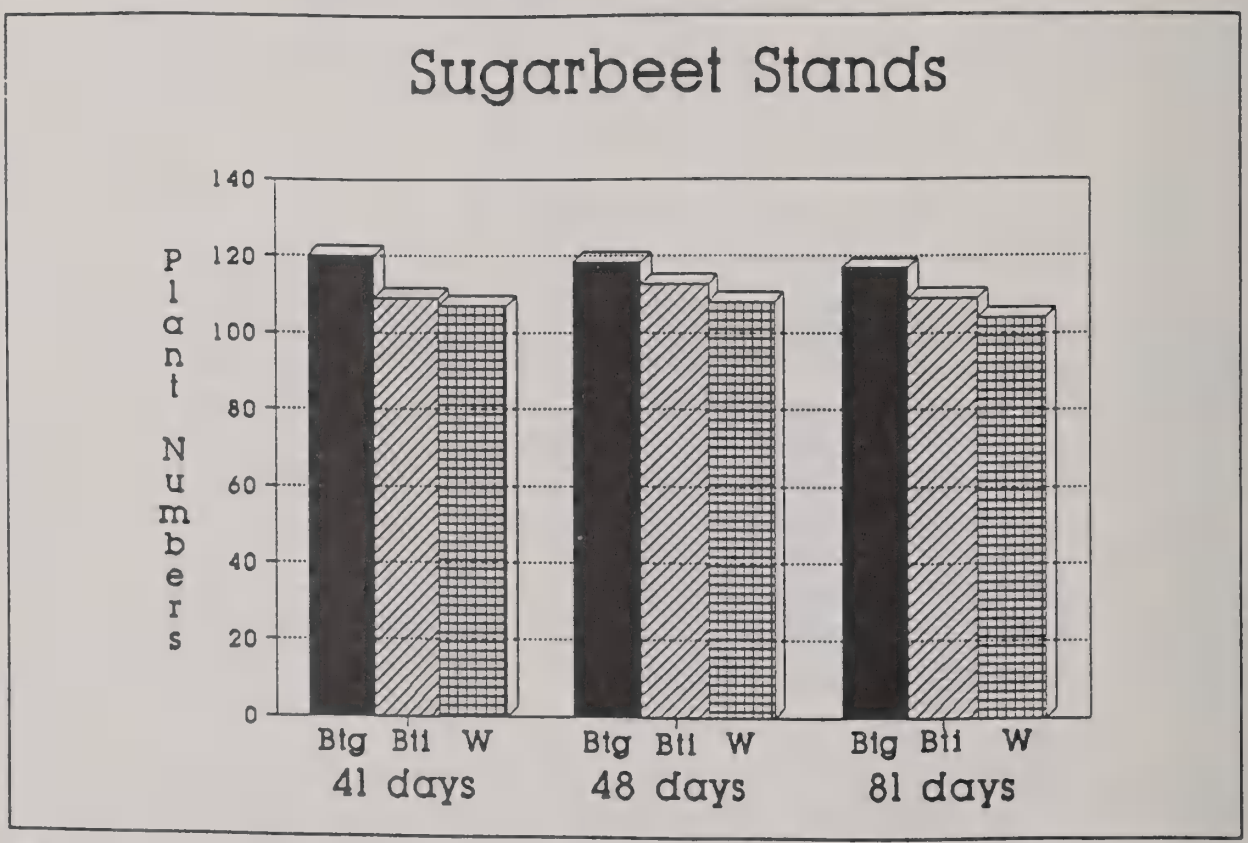

Figure 3. Sugarbeet stands recorded in field plots at St. Thomas, North Dakota, 1990. Stand counts taken 41 days, 48 days, and 81 days after planting.

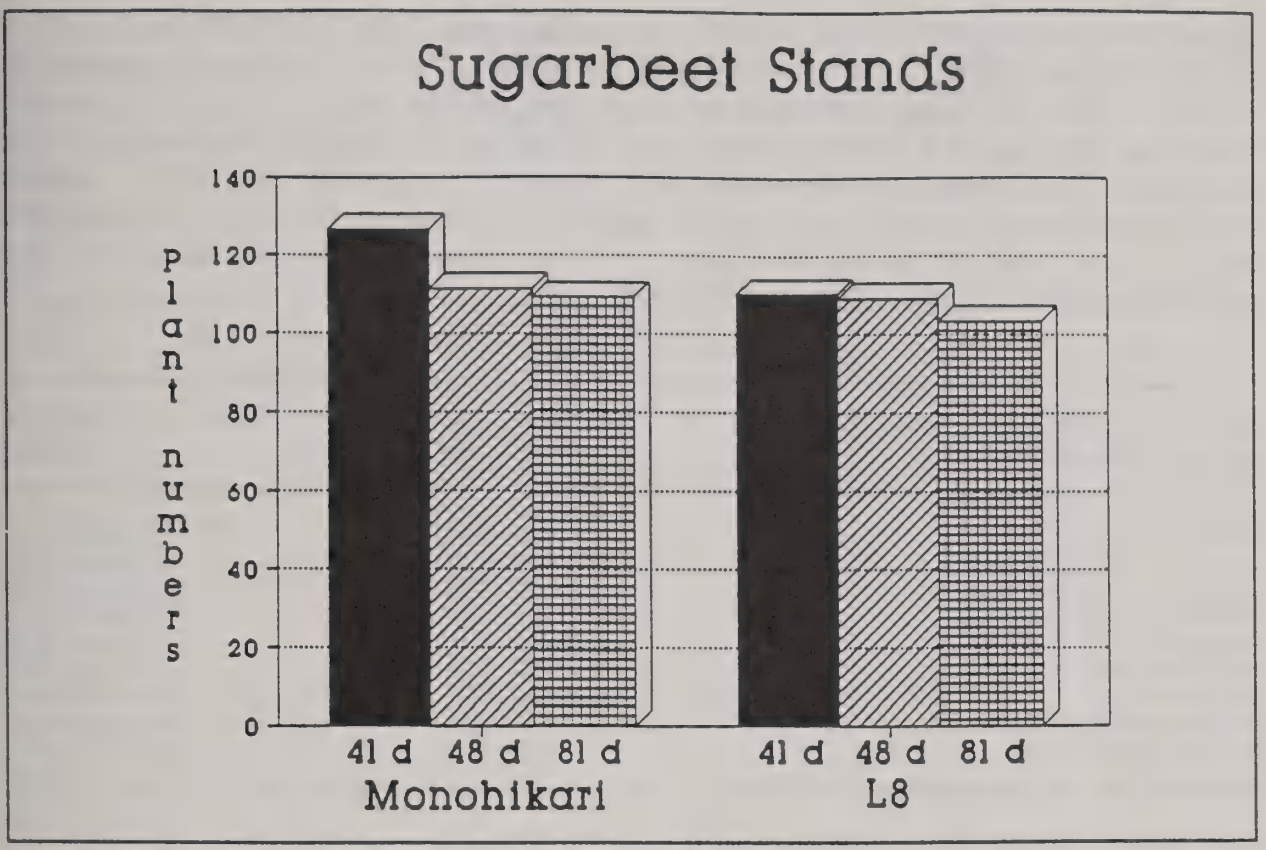

Figure 4. Sugarbeet stands recorded in field plots at St. Thomas, North Dakota, 1990. Stand counts taken 41 days, 48 days, and 81 days after planting.

Most importantly, there were no treatment differences as indicated by damage scale or by yield data and sucrose (Table 3). Although this test, which used soil surface banded application of two *Bt* strains, did not show any control effects, it does not preclude the possibility of effects if the bacteria were applied in other ways such as through the seed or a side-dressed granular application. On the other hand, *Bt* strains are known to be very specific as to insect target and neither of the two strains that we tested were known to be effective against *Tetanops myopaeformis*.

Table 3. Damage ratings, metric tons per hectare, and sucrose as a percentage of fresh weight.

Treatment	Damage	Metric Tons	Sucrose
B. thuringiensis galleriae	2.45	41.158	13.212
B. thuringiensis israelensis	2.50	42.044	13.150
Water	2.45	41.346	13.188

ISOLATION AND IDENTIFICATION OF BACTERIA FOR POTENTIAL USE AS VECTORS FOR ENDOTOXIN GENE INCORPORATION.--We have isolated a total of 30 rhizospheric and 35 endophytic bacteria have been isolated from sugarbeet for use as possible vectors for insertion of a toxin-producing gene for control of sugarbeet root maggot. The bacteria are being characterized by routine biochemical analyses for lecithinase, arginine dihydrolyase, potato soft rot, levan, gelatin and oxidase. Some of the organisms have been determined to be in the genus *Pseudomonas*. These organisms will be characterized for recolonizing ability on sugarbeet plants (Table 4).

Table 4. Bacterial characterization - percentage of bacteria testing positive using various assays.

Assay	Rhizospheric	Endophytic
Levan	10.0	91.4
Gelatin	10.0	94.3
Lecithinase	3.3	5.7
Oxidase	100.0	74.3
Arginine dihydrolyase	96.7	5.7
Potato soft rot	3.3	0.0

Since our biopesticide research program includes plant transformation (long term) and bacterial transformation (short term), we are also investigating *Agrobacterium* as a plant transformation gene vector.

Agrobacterium tumefaciens was isolated from eleven 1990 field grown sugarbeet galls. The galls were ground and samples of serial dilutions were plated on selective media D1 or New and Kerr containing 65 units ml^{-1} bacitracin and 30 μg ml^{-1} streptomycin. Isolates that tested positive for 3-ketolactose were tested for virulence on sugarbeet, tobacco, and sunflower plants. Antibiotic sensitivity was also examined.

Eleven of 81 strains isolated have been tested for virulence. None have displayed gall-forming ability comparable to the supervirulent *Agrobacterium tumefaciens* strain A281. We will continue to examine known and wild type *Agrobacterium* strains for use in our sugarbeet transformation program.

TISSUE CULTURE REGENERATION OF MAGGOT TOLERANT SUGARBEET GERMPLASM.--Variation exists within sugarbeet lines in respect to *in vitro* manipulation. We are interested in any germplasm which might be used in our biopesticide development program. We examined the callus, root, and shoot forming ability of a sugarbeet root maggot tolerant line designated L8. L8 leaves were collected from field grown material and sterilized by placement in 70% ethanol for one minute followed by washing in 10% bleach for 10 minutes. Two 7 mm leaf disks were placed on 100 X 15 mm petri plates containing 25 ml of the following media: B50, B51, TDZ1.25, B5M, B5M1, M20, or M100. The support medium was 0.9% agar or

0.3% gelrite. M20 and M100 contained MS salts, 30.0 g L^{-1} sucrose, plus 0.2 or 1.0 mg L^{-1} 6-benzylaminopurine. B50, B51, and TDZ1.25 contained Gamborg, Miller and Ojima's salts base, MS minimal organics, 20.0 g L^{-1} sucrose and no 6-benzylaminopurine, 1 mg L^{-1} 6-benzylaminopurine, or 1.25 mg L^{-1} thiadiazuron. B5M and B5M1 contained Gamborg's B-5 medium, 20.0 g L^{-1} sucrose, and no 6-benzylaminopurine or 1 mg L^{-1} 6-benzylaminopurine (Table 5).

Table 5. Percent leaf disks producing shoots and calli and size of calli produced.

Media	Shoots	Calli	Calli > 1 cm
M20 agar	0	67	0
M20 gelrite	0	100	0
M100 agar	0	100	50
M100 gelrite	0	50	5
B5M agar	0	100	0
B5M gelrite	0	0	0
B5M+BAP agar	0	63	0
B5M+BAP gelrite	0	50	0
TDZ1.25 agar	0	100	0
TDZ1.25 gelrite	0	100	0
B50 agar	0	0	0
B50 gelrite	0	0	0
B51 agar	0	90	0
B51 gelrite	20	80	20

Shoots readily formed on B51 media containing gelrite. Results of this test show that L8 can be manipulated in tissue culture should the need arise for use in our biopesticide development program.

RHIZOCTONIA ROOT ROT RESEARCH
(BSDF Project 610)

William M. Bugbee

The immediate objective of this research is to improve the method of identifying individual plants that have a high level of resistance to *R. solani*. The long range goal is to use the new technique to produce germplasm lines for sources of root rot resistance. Achieving this goal in a timely manner will be possible only if we gain a basic understanding of the sugarbeet's resistance mechanisms and develop the information to accomplish the objective.

The sugarbeet's biochemical mechanism of resistance can not be studied without first learning how the fungus attacks the plant. The significant role of pectolytic enzymes in pathogenesis is

well established. The approach here is to determine if pectolytic enzyme(s) are responsible for root rot of sugarbeet caused by *R. solani*. Several reports cite inhibition of pectolytic enzymes by host-produced proteins. If sugarbeet produces a pectolytic enzyme inhibitor, then this inhibitor might be manipulated to enhance root rot resistance.

PURIFICATION OF PECTIN LYASE INHIBITOR.--We have shown that the pectolytic enzyme pectin lyase (PNL) is an important cell-destroying enzyme produced by *R. solani* and that the sugarbeet produces a pectin lyase inhibitor protein (PNLIP). PNLIP plays a role in root rot resistance based on the results of three experiments showing that: 1) PNLIP content was related to varietal resistance, resistant FC 712 having more than susceptible Ultramono; 2) specific tissue resistance to the pathogen was associated with PNLIP content, with FC 712 roots having more than crowns; and 3) PNLIP *in vitro* protected tissue from damage caused by pectin lyase. Purification and analysis of PNLIP from whole root extract this past year has shown the inhibitor to be complex, consisting of four units ranging in molecular mass of 3 to 28 kD. Each of these units contained subunits that were resolved by isoelectric focusing. A PNLIP also was extracted with a saline buffer from root cell walls that had been washed free of soluble sugars, proteins, etc. The extract was desalted and subjected to isoelectric focusing in a liquid phase using Bio-Rad's Rotofor unit. PNLIP was detected in six fractions (Table 6). Each of these fractions were desalted and reduced by lyophilization. Samples were analyzed by gel electrophoresis and showed a single major band at 40 kD in fractions 11 to 15. This appears to be a quick method for purifying PNLIP that is bound to cell walls.

Table 6. Pectin lyase inhibitor protein (PNLIP) detected in root cell wall extracts resolved by isoelectric focusing.

Fraction	pH	Units of PNLIP
11	6.83	11
12	6.87	20
13	7.06	22
14	7.47	48
15	7.99	20
16	8.39	9

IMMUNOASSAY FOR PNLIP.--Both monoclonal and polyclonal antibodies have been made to PNLIP in cooperation with Dr. Dave Gabrielsen of the Department of Microbiology and Veterinary Science at North Dakota State University. These antibodies are being used to develop a double antibody sandwich enzyme-linked immunoassay (DAS-ELISA) to detect PNLIP in plant extract. The assay is being optimized. This requires trial and error to find the correct dilutions of the agents used in the assay, and the incubation time and temperatures that will render a positive color reaction within a reasonable amount of time. Preliminary results with DAS-ELISA, detected PNLIP in extracts from both root and petiole; therefore, petioles will be used for further experiments because of the obvious ease of collection and minimal damage to the plant. The extract was simply prepared by squeezing a detached petiole base with pliers. One μl of extract was all that was required but in practice, 5 μl were diluted. Plants 1.5 or 2.5

months old have been assayed. The level of PNLIP in the root-rot-resistant germplasm FC 712 was higher than in the root-rot-susceptible cultivar Ultramono but not consistently. It is possible that the difference in PNLIP content between resistant and susceptible plants becomes greater with age. This hypotheses is supported by the fact that seedlings of resistant germplasm lines are as susceptible as nonselected lines.

In another test, DAS-ELISA was used to quantitate PNLIP in petiole extract. The results in Table 7 show that the PNLIP content in root-rot-resistant FC 712 was twice that of Ultramono but the variability was high among the five plants. The standard curve that was used to calculate PNLIP was based on a serial dilution of purified PNLIP. Future assays will not be based on a PNLIP standard curve because this protein is expensive and time-consuming to purify. Rather, assays will be based on PNLIP content that is relative to standards of resistant and susceptible germplasm lines run concurrently with all test entries. It is emphasized that this is but one test and the protocol must be optimized and standardized to ensure repeatability. That goal has not yet been reached.

Table 7. Pectin lyase inhibitor protein (PNLIP) content in petiole extract of root rot resistant FC 712 and suseptible Ultramono. Standard curve was based on purified PNLIP.

	μg of PNLIP in Each of Five Plants					
	1	2	3	4	5	avg.
FC 712	43	4	20	38	23	26
Ultramono	15	1	16	28	3	13

If planned experiments prove that PNLIP is related to root rot resistance, then young, individual plants with high levels of PNLIP can be identified using DAS-ELISA.

PROTEOLYTIC ENZYMES FROM *R. SOLANI*.--Many plant pathogens produce enzymes that depolymerize proteins. Cell walls and membranes contain proteins; therefore, proteolytic enzymes may be involved in causing disease. It is reasonable to expect that pectinases and proteases could function together to cause disease. In a recent report (*Physiol. Mol. Plt. Path.* 36:303, 1990), the degradation of carrot cell walls by pectin lyase increased 40% when the walls were pretreated with proteinase. Our preliminary tests show that proteinase activity was present in crude culture broth of *R. solani*. The optimum pH for activity in those tests was 7.5. The enzyme has now been partially purified and resolved by preparative isoelectric focusing. Activity was broad, being present in fractions ranging from pH of 2.99 to 13 with the peak at 11.3. Pectin lyase activity co-migrated with the protease with peak activity at pH 9.88 to 10.49 (Table 8).

Table 8. Proteinase and pectin lyase detected in root cell wall extracts resolved by isolectric focusing.

Fraction No.	pH	Proteinase Units	Pectin Lyase Units
1	1.55	0	0
2	1.81	0	0
3	2.06	0	0
4	2.39	0	0
5	2.99	21	0
6	3.76	13	0
7	4.08	12	0
8	4.59	14	0
9	5.11	31	0
10	5.69	19	36
11	6.37	37	33
12	7.05	31	37
13	7.78	24	55
14	8.40	49	111
15	9.16	110	148
16	9.88	193	166
17	10.49	262	167
18	11.27	272	162
19	12.80	192	85
20	13.09	94	0

The theory that *Rhizoctonia*'s proteinase and pectin lyase function synergistically to cause more damage together than alone will be tested as soon as the two enzymes are separated and partially purified.

SUGARBEET ROOT MAGGOT RESISTANCE BREEDING
BSDF Project 620

L. G. Campbell

The sugarbeet root maggot (*Tetanops myapaeformis*) continues to be an economically important pest in the Red River Valley and throughout much of the United States. The need for host plant resistance became more apparent in 1990 when some commonly used insecticides failed to provide adequate control. A limited breeding line development program for maggot resistance has been in progress for several years in North Dakota. Some material presently in the breeding program has a level of resistance that provides control comparable to the control obtained from some widely used insecticides. The most resistant germplasms (L-3, L-8, and L-10) were selected for resistance previously in Idaho before being further selected in North Dakota (Table 3). Three heterogeneous populations representing diverse genetic backgrounds (CFM, CHM, and H-537) have been selected a few generations at St. Thomas, North Dakota. These populations have moderate resistance. The difference between the two groups of breeding lines is indicative

of the slow progress generally observed in selecting for maggot resistance. Because of the difficulty and time involved in transferring resistance to a company's elite parental lines, the present sources of resistance probably will not be used widely. Both the seed parent and the pollinator would need to have resistance for effective control in commercial production. To help offset this fact, we are converting our most resistant diploid lines to tetraploid lines. A resistant tetraploid pollinator would increase the genetic contribution of the pollinator and might provide a useful level of resistance in a hybrid. We also plan to use progeny tests to improve our selection efficiency.

Table 9. Sugarbeet root maggot damage ratings, St. Thomas, North Dakota, 1989 and 1990.

	Rating*		
Designation	1989	1990	2-Year Mean
L-3	2.4	1.5	1.9
L-10	2.2	1.8	2.0
L-8	2.2	1.8	2.0
CFM	3.1	2.5	2.8
Monohikari	3.3	3.0	3.2
Maribo-403	3.6	3.3	3.4
KW 1132	3.5	3.4	3.4
Beta 6625	3.5	3.5	3.5
Hilleshög	3.5	3.6	3.6
Check mean	3.5	3.4	3.4
LSD $_{0.05}$	0.5	0.3	-

* 0 = no damage to 5 = severely damaged.

EFFECTS OF TEMPERATURE AND SEED LOT ON SEEDLING EMERGENCE

L. G. Campbell

Rapid stand establishment facilitates early season weed control and, in some years, may be a factor in avoiding soil crusting and reducing seedling diseases. The need to balance early seeding and adequate stand establishment requires an understanding of the factors influencing stand establishment. Low temperatures may prevent or delay emergence while freezing temperatures may kill newly emerged seedlings. Hybrids and different seed lots of a single hybrid may emerge at different rates. These factors were examined in the laboratory by observing emergence through sand on a thermogradient plate. A thermogradient plate allows simultaneous examination of many hybrids at temperatures between 50 and 77° F. Fourteen commercial hybrids were examined in 1985 and 1986. Seed was obtained from commercial

sources and new seed lots were obtained for each year's test. Seed quality at the time of planting duplicated that encountered in commercial production.

In general, percent emergence after two weeks and rate of emergence were higher in 1985 than in 1986. Significant hybrid X year interactions indicated that large differences among seed lots of a hybrid existed. This is further illustrated by the differential emergence of the five hybrids in Figure 5. Hybrid B had a higher emergence percent than hybrid A. This difference was consistent across years and is in contrast to the inconsistent emergence of hybrid E. This contrast makes apparent the difficulty in characterizing hybrids for emergence percent (seedling vigor). There may, in fact, be differences among hybrids; however, any valid comparison between hybrids must attempt to minimize differences due to seed lot. Research in other crops has demonstrated that the seed production environment influences seed quality.

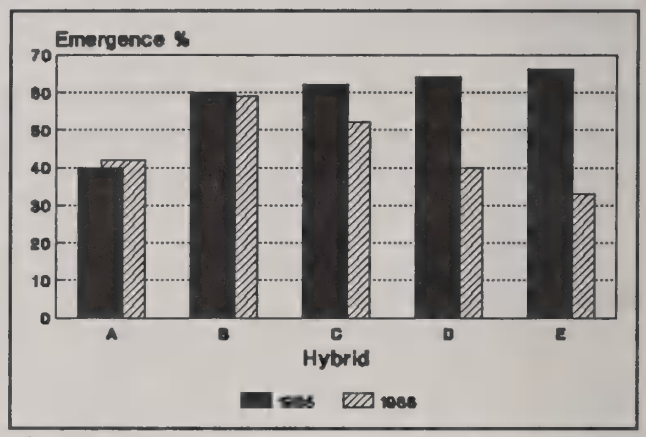

Figure 5. Emergence % 14 days after planting for five hybrids in 1985 and 1986, averaged over temperatures between 50 and 77°F.

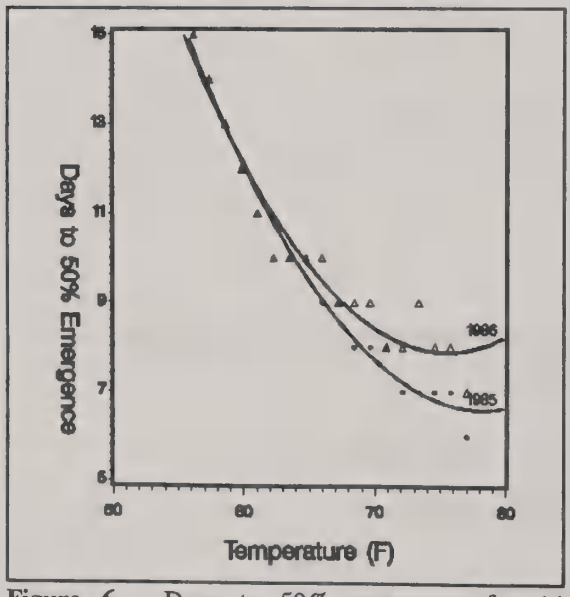

Figure 6. Days to 50% emergence for 14 sugarbeet hybrids at various temperatures on a thermogradient plate in 1985 and 1986.

Seedlings emerged faster in 1985 with the difference between years increasing as the temperature increased (Figure 6). Days to 50% emergence appeared to reach a minimum at approximately 75°F in both years; however, an additional day was required for 50% emergence in 1986. More than 14 days were required for 50% emergence at temperatures below 57°F in both years.

Data from the thermogradient plate were used to calculate the heat units required for 50% emergence. Heat units then were used to estimate field emergence times at Fargo (Figure 7). Between 15 April and 31 May average soil temperatures (1981-1989) increased from 42 to 59°F at a rate of 0.5°F per day. For seed planted on 15 April, 23 days were required for 50% emergence, compared to 10 days for a 15 May planting. The earliest average planting date for obtaining a 50% stand in 14 days or less was 28 April; in ten days or less, 13 May. The probability of a killing frost (28°F) after these dates is 70% for 28 April and 20% for 13 May. Soil warming rates are extremely variable from year to year. For example, for a 15 April planting in 1987 one would have expected a 50% stand by 27 April; a 15 May planting would have 50% emergence on 26 May. This pattern is in

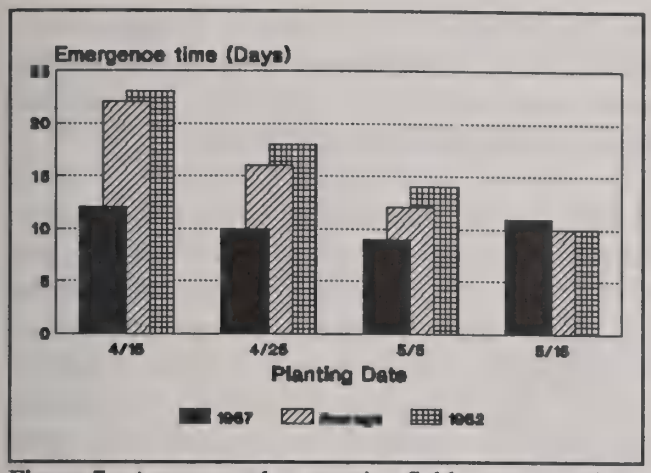

Figure 7. Average and contrasting field emergence times for selected planting dates, based upon heat units required for emergence.

sharp contrast to 1982 when a 15 April planting would not have reached 50% emergence until 8 May. This is only 17 days earlier than the 25 May emergence date expected for a 15 May planting. This contrast suggests a feasible explanation for inconsistency in the benefit of early planting. Predicted emergence times should be considered minimum times. If a seedbed is dry at planting, the day that adequate rainfall occurs may become the effective planting date. Planting depth and seedbed conditions also influence emergence time; however, relative times would remain similar to those reported here.

PHYSIOLOGICAL SELECTION AND GERMPLASM RESEARCH
(BSDF Project 630)

Devon L. Doney

Improvement of production efficiency is time consuming and thus long term. The effects of a large environmental genetic interaction coupled with the negative correlation between sucrose and root yield make potential improvement even more difficult. Most breeders utilize such methods as top crosses, test crosses, diallel crosses and paired crosses to identify superior combining parental lines. These are evaluated in large replicated field trials. These approaches, although effective, are expensive and time consuming. Selection methods that could identify superior genotypes on an individual plant basis would greatly enhance the speed and effectiveness of production improvement. The following are methods being investigated which may have the potential for increasing the efficiency of selection.

STRESS SELECTION.--This is a greenhouse method designed to identify genoptyes in the seedling stage that store sucrose in the early growth phases. This method has been developed over the past few years and is now in the evaluation stage. Earlier studies have shown small positive increases in both sucrose concentration and root yield from one cycle of selection. This method appears to be more effective in improving root yield than sucrose concentration. However, in no case has sucrose concentration been reduced while increasing root yield. Several selection cycles have been achieved in three populations. This past year seed was produced from the selected populations and from crosses to common females. These will be evaluated in replicated field trials. It will take at least two years of field testing to determine the effectiveness of this new selection approach.

GREEN LEAF DURATION.--Characteristics of the sugarbeet canopy such as 1) a genetically alterable partitioning of the photosynthate to the root or top, 2) excessive leaf canopy throughout much of the growing season, and 3) the continuous dying and initiation of leaves, suggests that an extension of the leaf life span might increase sucrose storage and production.

Last year, I reported on research designed to identify genetic variation for green leaf duration. Sufficient genetic variation was recognized to warrant additional studies. Selections were made for divergence in leaf life span. These selections were conducted under uniform growth chamber conditions using a very heterozygous population. From this population, two new populations were produced, one for early senescence (v763) and one for late senescence (v762). A second cycle of selection was achieved by selecting early senescing plants from population v763 and late senescing plants from population v762. All new populations resulted from intercrossing (open pollination) selected plants.

The resulting four populations v763 (early), w250 (early-early), v762 (late), and w249 (late-late) along with the parent population (WC5) were tested under similar growth chamber conditions. This test consisted of 85 plants from each population arranged in a completely randomized design. Data were taken for leaf initiation, leaf growth of the first six leaves, and leaf senescence of the first two leaves.

Plants from early senescence selected populations initiated leaves faster than plants from late senescence selected populations (Figure 8). The difference in leaf initiation between the earliest (w250) and the latest (w249) senescing populations increased with each succeeding set of leaves (three-fourths day for the first two leaves to two and one half days for leaves 5 and 6). These data suggest that all leaves were initiating more rapidly in the early senescing population than in the late senescing population.

Leaf growth also appeared to be more rapid in the early senescing population (Figure 9). The time it took leaves to expand from one cm in length to 10 cm in length was used as a measure of growth rate. Trends in leaf growth rate for all three sets of leaves were toward faster leaf growth rate in the early senescing populations; however, it wasn't until the third set of leaves that these trends became significant (Figure 9).

The green leaf duration (days from planting to leaf senescence) of the first true leaves are given in Figure 10 (population means). There was a significant difference among populations. Population w250(early-early) had the shortest and population w249(late-late) had the longest green leaf duration. The green leaf duration of the parent population (WC5) was intermediate. Population w250(early-early) was three days shorter and population w249(late-late) four days longer than the parent. These results indicate that green leaf duration in sugarbeet is genetically controlled and can be altered by appropriate selection procedures.

Populations v762(late) and v763(early) were tested in a replicated field trial this past summer. The v762(late) population significantly outyielded the v763(early) population; however, this difference was probably due to the high number of annuals in the v763(early) population. There was a low frequency of annuals in the original population (WC5). Unfortunately, the v763(early) population had a much higher frequency of annuals than the parent and the

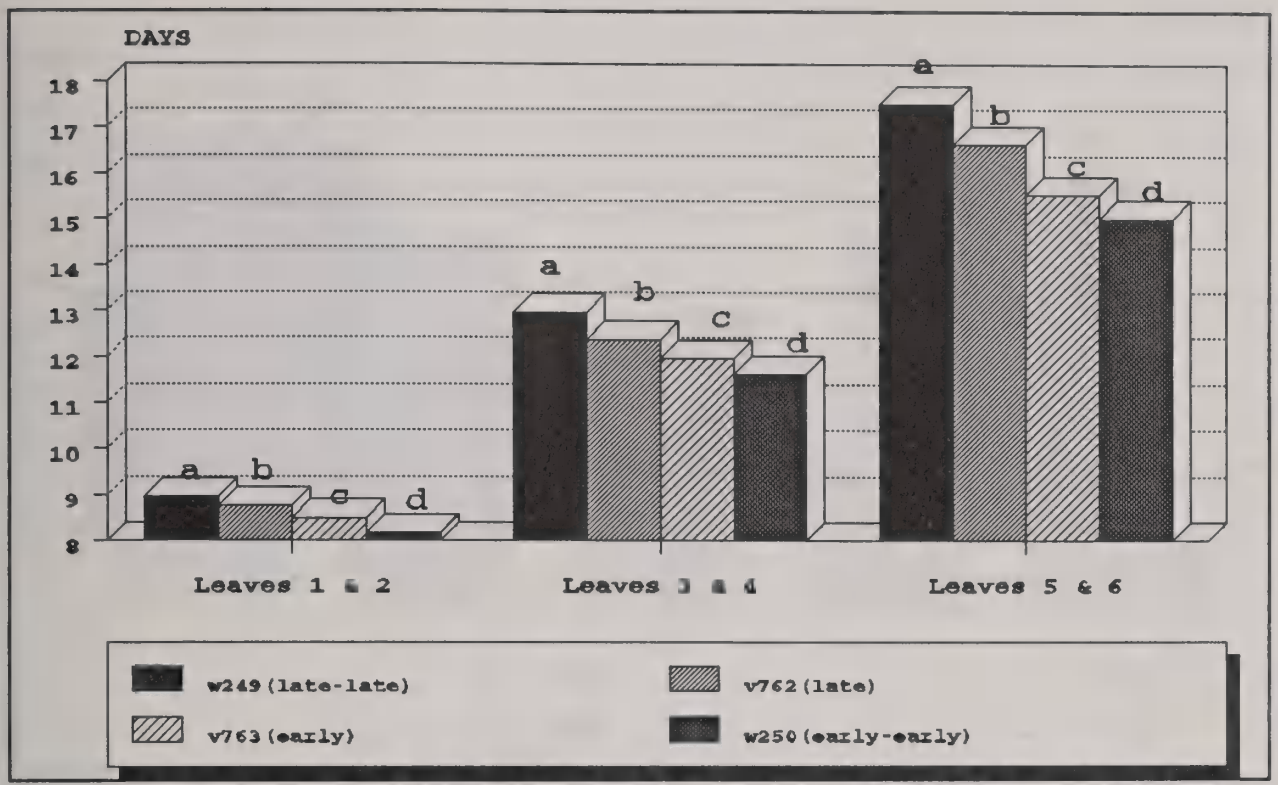

Figure 8. Days from planting to leaf initiation of the first three sets of leaves for two cycles of divergent selection. Letters above bars indicate significant differences at $P = 0.05$.

v762(late) population exhibited fewer annuals. This unexpected shift in the frequency of annuals was either due to random genetic drift or to a pleiotropic effect of selection pressure for green leaf duration. This disparity in annualism significantly affected the results of the field trial.

GERMPLASM ENHANCEMENT.--Three new dynamic populations (crosses between wild types and a sugarbeet genetic male sterile) were obtained this past year. These populations will be open-pollinated at least once prior to any selection effort. Similar populations that have gone through three cycles of selection were screened for root shape and biennial habit.

GERMPLASM EVALUATION.--Sixty accessions of the NC-7 collection were evaluated for high priority descriptors. This is a continuous program and is conducted by scientists in the U. S. with expertise in the respective descriptors. Although much of the evaluation is descriptive, a number of accessions have been found to carry resistance to some of our major sugarbeet pests in the U.S.

The entire French, Belgium, and Danish collections (3200 accessions) were evaluated for growth, canopy, and flower characteristics. Following are some of the conclusions of this extensive evaluation:

Bolting: Almost 100 percent of the plants collected in the Gulf of Lion (Mediterranean Sea coast) were annual as well as those collected in and around Nerac, located in southwestern

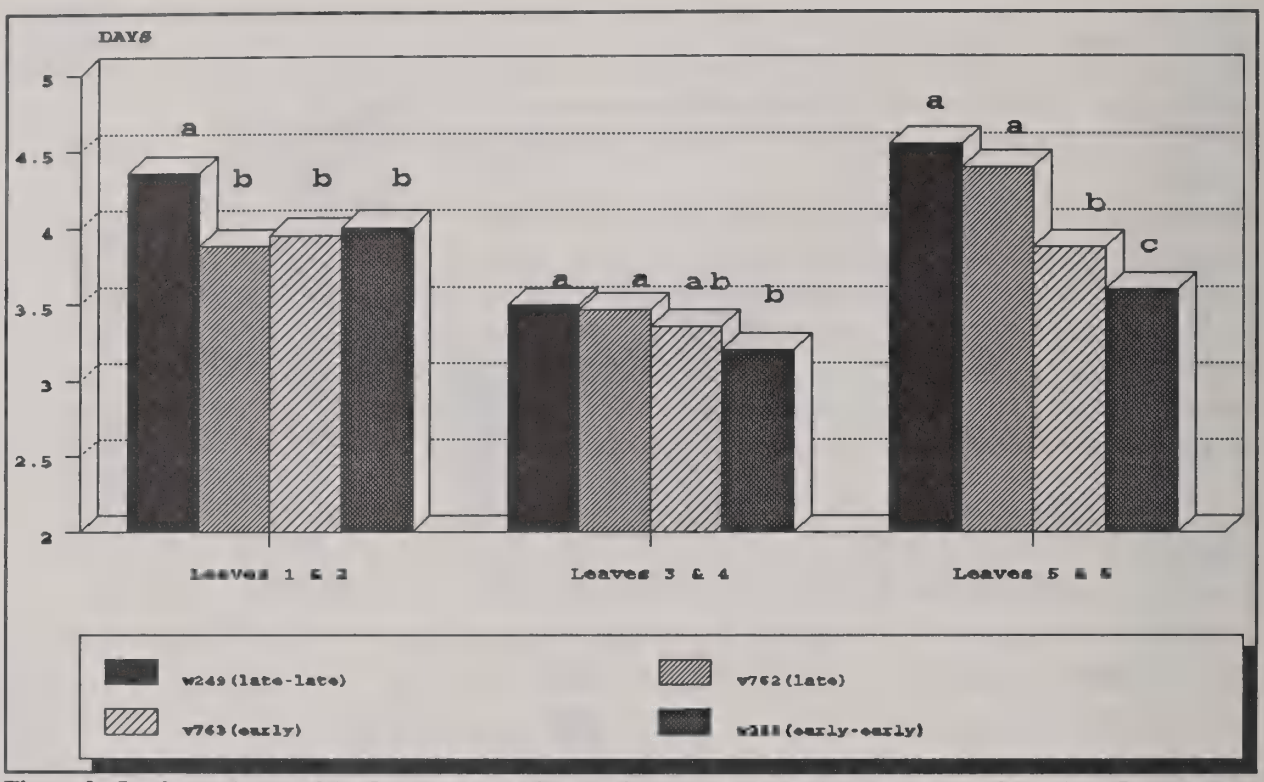

Figure 9. Leaf growth rate of the first three sets of leaves for divergent selection for green leaf duration. Letters above bars indicate significant differences at $P = 0.05$.

France just west of Toulouse. Nerac is the area of sugarbeet seed production in France. This is the only location in France where wild beets are found inland. The number of plants bolting from collections obtained on the southern Atlantic French Sea coast was around 50 percent. This percentage of bolting plants decreased from 50 percent in the south Atlantic sea coast of France to less than 5 percent on the North Atlantic French coast. All plants collected in Denmark were biennial.

Germs per seed ball: Most plants had 3-6 germs per seed ball, however, several plants were found with monogerm seed and a number with two seeds. The average number was between three and four. Populations with the largest number of germs/seed ball were in the Bordeaux, LaRochelle areas (4-5).

Leaf rosette: The most erect leaves were found in the Nerac area. Those collected in the Gulf of Lion were also quite erect. Plants collected on the Atlantic coast were mostly procumbent with the southern collections being the most erect and the northern collections most prostrate. The Danish collections were the most prostrate of all.

Growth habit--seed stalk: The seed stalk erectness character behaved very similarly to leaf erectness. Those collections from the Mediterranean and Nerac areas had erect seed stalks, whereas the Atlantic collections were more procumbent. No plants from the Danish collection flowered; however, many produced vegetative seed stalks that were prostrate.

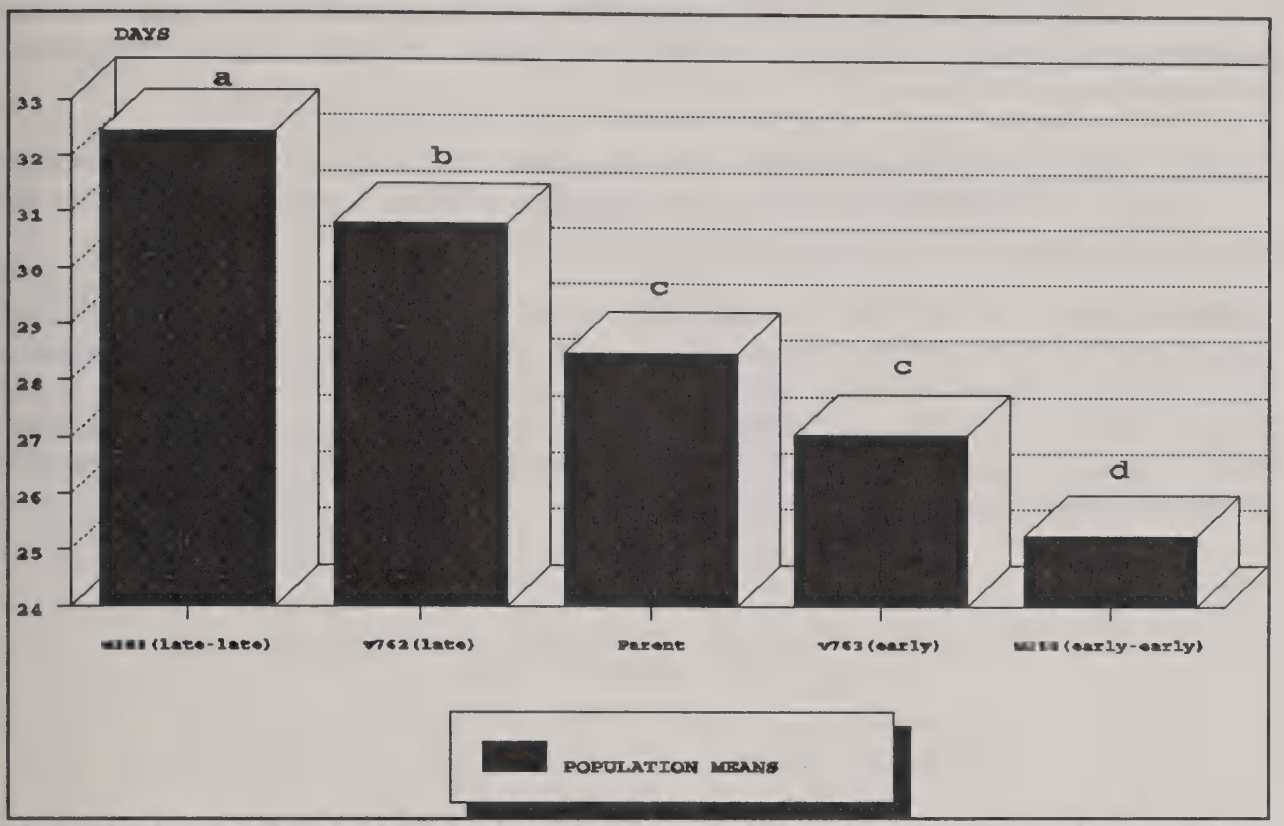

Figure 10. Green leaf duration of first true leaves for two cycles of divergent selection. Letters above bars indicate significant differences between populations at $P = 0.05$.

Petiole color: All plants from the Mediterranean and Nerac areas had green petioles. Those from the Atlantic coast were segregating for red petioles. Some populations had a higher frequency than others but there was no trend from south to north. There were no red petioles found in the Danish collection but there were a significant number of plants with pink petioles.

Stem pigmentation: Collections made in the Nerac area all had green stems. All other collections had a few to many red striped stem stalks. Those collections with the least stem pigmentation were found in the Gulf of Lion and northern Atlantic coasts. The highest frequency of stem pigmentation was found in Brittany and the Channel Islands areas.

Leaf color: Most leaves were classified as green. Several plants with light green color were found on the southern Atlantic coast. Most populations were also segregating for low frequency of red veins.

These data lead me to conclude that the weed beets found in the commercial fields of Northern Europe are not outcrosses with the Atlantic wild beets. This conclusion is based on the following observations: 1) North Atlantic wild beets are mostly biennial whereas the weed beets are very annual, 2) North Atlantic wild beets are procumbent to prostrate in growth habit compared to the erect habit of the weed beet, 3) the wild beets found in the Nerac area more closely resemble the weed beet than any found on the Atlantic coast, 4) wild beets found in the Mediterranean are more characteristic of the weed beets and the wild beets found in the Nerac

area. I therefore believe that the weed beets are from outcrosses with the wild types found in the Nerac area, which were probably introduced many years ago from outcrosses of sugarbeet to Mediterranean wild beets.

GERMPLASM MULTIPLICATION.--100 accessions of the NC-7 collection needing regeneration were multiplied under controlled isolation conditions. Careful surveillance of the seed multiplication program resulted in higher quality and quantity of seed regenerated.

GERMPLASM COLLECTION.--A collection expedition to the Armenia and Daghestan Republics of the USSR returned several collections of wild germplasm that had not previously been collected. These accessions will be deposited at the NC-7 repository in Ames, Iowa. Passport data will be entered into GRIN. Accessions of section Corollinae and ssp. *maritima* were obtained this past year from the USSR and Greece, respectively. These were obtained through reciprocal seed exchange agreements.

SUGARBEET RESEARCH

1990 Report

Section E

Michigan Agricultural Experiment Station,
East Lansing, Michigan

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Cooperation:

Michigan Agricultural Experiment Station at
East Lansing, MI

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CONTENTS

PUBLICATIONS

Abstracts of Papers Published or Approved for Publication and Germplasm Releases

Doney, D. L. and Theurer, J. C. 1990. Osmolarity of L19 sugarbeet germplasm. J. Sugar Beet Res. (Accepted for publication August 1990)

Since sucrose is the major soluble particle in mature sugarbeet root cells, differences in sucrose concentration should correlate with osmotic concentration. Osmotic concentrations were measured from frozen root tissue of 5-wk-old seedlings with a vapor pressure osmometer. Tests were conducted under different levels of N fertility, drought, day length and temperature and for a wide range of commercial hybrids, experimental hybrids and inbreds. Osmotic concentrations in sugarbeet seedlings were not affected by different levels of N fertility, drought and temperature even though plant growth was significantly affected by these parameters. Correlations between seedling osmotic concentration and sucrose concentration at harvest were significant in two experiments and at harvest were significant in two experiments and non-significant in two others. Tests giving significant correlations were largely due to the high sugar L19 inbred or hybrids with L19 inbred as a parent. This inbred consistently gave significantly higher osmotic concentrations than the other cultivars.

Potchen, E. J., Halloin, J. M., Cooper, T. G. and Smucker, A.J.M. 1990. Magnetic resonance imaging of plants. In A.J.M. Smucker and S. H. Anderson (eds.) Analytical Methods for Quantifying Root and Soil Dynamics Conf. Abstr. International Symposium. St. Louis, MO., Aug. 1990.

Magnetic resonance imaging and spectroscopy provide a novel way to assess the structure and chemistry of living tissue. A dominant emphasis has been on the assessment of human brains. The potential to appreciate the structure and chemistry of both the normal and diseased plant suggests an unusual opportunity to improve our understanding of plant architecture and development. We have attempted imaging of normal plant materials, and found it useful to analyze the magnetic resonance signal characteristics emanating from the various chemical constituents, which differentiate plants from the known aniaml data. We have studied the fruits and stems of a variety of plant materials. In addition, we have looked at specific crop roots, e.g., sugarbeets and the growing root in corn. The signal characteristics of the plants and some of their chemical constituents will be presented, in addition to background information as to the nature of the magnetic resonance signal and factors that are known to influence signal intensity.

Saunders, J. W. 1990. Sugarbeet resistance to sulfonylurea herbicides from somatic cell selection. Abstr. VIIth Int. Congr. Plant Tissue & Cell, A48-85.

REL-1, a model sugarbeet clone bred for tissue culture applications and rapid generation time, is an annual self-fertile diploid genotype with superior shoot regeneration and suspension cultures. Dispersed suspension cultures were produced from callus induced on REL-1 leaf discs by MS medium + 1.0 mg/L 6-benzyladenine (BA). Suspensions were subcultured twice in liquid MS + 1.0 mg/L BA before plating of unmutagenized cell clusters on 2.8 nM chlorsulfuron in MS + 1.0 mg/L BA with agar. A single colony survived from which shoots were extracted, propagated as shoot cultures, and treated as separaate isolates. In vitro shoot tolerance to chlorsulfuron is 100-300 fold greater in the resistant isolates than in REL-1. Resistance is quickly and non-destructively ascertained in leaf disc expansion tests in vitro with MS + 1.0 mg/L BA. Resistance has behaved as a monogenic dominant in field, glasshouse, and in vitro shoot tests. This resistance has been released to the public as vegetative propagules of one isolate (CR1-B), and the resistance is being backcrossed into an elite smooth root breeding background for future release. Most of the twelve resistant isolates can be distinguished from each other by whole plant phenotype or recessive traits segregating in S_1 progeny. One resistant isolate is the source of a dominant foliar tumor trait.

Saunders, J. W. 1990. Release of herbicide resistant germplasm CR1-H.

CR1-H is at least 300x less sensitive to chlorsulfuron and primisulfuron than S1 seed of clone REL-1 from which it was derived. CR1-H is homozygous for resistance, which is inherited in a monogenic dominant manner. CR1-H was produced by selfing ramets of CR1-AB-1-3, an S1 plant from CR1-AB. CR1-AB was derived from susceptible clone REL-1 by regenerating a shoot from callus developed from a cell cluster surviving in vitro exposure to 2.8 nM chlorsulfuron. CR1-H is thus the S2 generation following regeneration from callus. Vigor of CR1-H is depressed due to inbreeding and possibly due to segregation out of quantitative somaclonal variation factors. CR1-AB is a sister isolate, regenerated from the same surviving callus, of clone CR1-B released in 1989. CR1-H is diploid with N cytoplasm, segregating for annual and biennial flowering habit, red and green hypocotyl, and multigerm and monogerm seed character. It is homozygous for the self-fertility factor, and is a near type O lines. The genetic background of CR1-H is 50% 6926-0-3 (a selection from SP 6926), 25% Owens Annual Tester, and 25% 58-81 (an East Lansing breeding clone selected for resistance against Aphanomyces cochlioides). Pollen production in CR1-H is variable. It is expected that the herbicide resistance trait will have to be backcrossed into more favorable genetic backgrounds before it appears in commercial hybrids.

Theurer, J. C. 1990. Release of smooth root soil-free germplasm SR87.

SR87 is being released as a germplasm source for breeders to use in developing smooth root breeding lines or cultivars. SR87 is a self-incompatible multigerm progeny segregating for red and green hypocotyl, with good resistance to Cercospora leaf spot. The original parentage was from G. W. Demings globe-shaped root progenies (selections from table beet x sugar beet) crossed with SP6822-0 MM, the pollen parent of hybrid USH20. Selected smooth root beets were backcrossed after the first and second cycles of selection to highly resistant Cercospora and Aphanomyces root rot resistant sugarbeets. Subsequently, five cycles of recurrent mass selection were made for smooth soil-free roots while eliminating large crown and split crown beets. SR87 is machine harvested with 25-30% of the soil adhering to the tap root compared with commercial hybrids. In two year field trials, hybrids having SR87 as pollinator averaged 103% root wright, 88% sucrose percent, and 100% clear juice purity of the commercial hybrid Mono-HY E4.

Papers published since abstracted in previous report.

Aicher, L. D. and J. W. Saunders. 1990. Inheritance studies and clonal fingerprinting with isozymes in sugarbeet. Crop Sci. 30:1064-1072.

Saunders, J. W., Doley, W. P., Theurer, J. C. and M. H. Yu. 1990. Somaclonal variation in sugarbeet, pp.465 490. In Bajaj, Y.P.S. (ed.) Biotechnology in Agriculture and Forestry, Volume 11. Springer Verlag, Berlin, Germany.

SELECTION AND EVALUATION OF SMOOTH ROOT GERMPLASM

J.C. Theurer

Two experiments were conducted in the field in 1990 at the Beet and Bean Research Farm in Swan Creek, MI to evaluate the performance of smooth root germplasm. Experiment 905 was a second year continuation of an experiment to observe the agronomic performance of a smooth root line, SR87, compared with MHE4, a commercial hybrid cultivar, when grown under different plant densities. Minirhizotron studies have shown that the fibrous root system of SR87 develops differently in the soil profile. In addition, it may be that the smooth root type beet does not have the extensive fibrous root system of a standard variety, which could be a burden to a smooth root variety under environmental stress such as a drought. Growing beets under high density plantings might also cause plant-to-plant competition which could have an adverse effect upon root growth and sucrose accumulation. In this experiment, we sought to observe any undesirable characteristics of growing beets with the smooth root character.

The second experiment was established to compare the agronomic performance and other characteristics of 3 smooth root varieties. These included the East Lansing smooth root line SR87, a globe-shaped variety bred by Dr M. Mesken in the Netherlands, and a relatively soil-free European commercial variety, Univers, developed by the Van Der Have Company in the Netherlands.

Materials and Methods

Experiment 905

This experiment was a repeat of Experiment 898 grown at the B&B Farm in 1989. SR87 and MHE4 varieties were planted May 3, 1990, with a cone planter in strip plantings at four different row spacings; the standard 28", and 22, 20, and 18". The strip planting method was used so that the plots could be machine harvested. Individual plots consisted of 3 rows for the 28" spacing and 4 rows for each of the other row spacings in order to fit between the tracks of a tractor with tires spaced 88" apart. Plots were 25' long and there were 3 replications in the experiment. After 5 weeks growth, the plants were thinned within the row to a predetermined, randomized design resulting in half of the plots of each variety with plants spaced 6" apart within the row and the other half with a 12" plant-to-plant within-row spacing. Harvest was completed on November 1, 1990, using a 2-row machine. The two center rows of each 4-row plot and 2 of the rows of each 28" plot were harvested by adjusting the harvester puller wheels to fit the plot width. All beets of a plot were weighed for root yield, and a 15-beet sample from each plot was used to determine sucrose percentage and clear juice purity. The laboratory analyses for these determinations were made by Michigan Sugar Company personnel in their lab at Carrollton, using standard technology.

Experiment 907

Five varieties were planted in this experiment. The globe-shaped entry was developed by Dr Mesken at the breeding station in Wageningen, Netherlands, by selecting for several years in a population of beets from a cross of table beet x sugarbeet. This variety, which he was kind enough to

supply for the field test, was a triploid hybrid. SR87 smooth root line which was released this past year from our breeding program at East Lansing station, was the other smooth root variety in the test. The third entry was a Van Der Have commercial variety which is grown quite widely in Europe because of its small root grooves and relatively soil free characteristics at harvest compared with standard root type varieties. The other 2 entries in the test were the commercial varieties MHE4 and ACH 176, which were used as comparison checks. The experiment was a randomized block of 4 replications. Each individual plot consisted of two 28' rows spaced 28" apart. The experiment was planted May 2, 1990, and harvested October 23, 1990, using our single row mini-harvester. Roots from each plot were weighed, the soil cleaned from each root, and then reweighed to get an estimate of the quantity of soil harvested with each variety. A 15-beet sample was selected for sucrose and clear juice purity analyses.

Results

Experiment 905

The analysis of variance showed significant differences between row spacings when summed over both varieties for RWST and sucrose percentage, but not for root yield, RWSA, or clear juice purity. Differences between 6" and 12" within-row spacing was noted for RWSA, RWST, and CJP percentage. RWSA was the only variable showing significance for between-row x within-row interactions. The 2 varieties were significantly different for each measured trait (Table 1). As observed in other tests, SR87 was higher in root yield and significantly lower in sucrose percentage, RWST, and clear juice purity than MHE4. Variety x row spacings were significantly different for tons/acre and RWSA. MHE4 had highest root yield at 28" row spacing and decreased in yield as row distance narrowed. Conversely, SR87 had highest root yield in 22" rows followed by 20", then 18", and was significantly better than the 28" row spacing. RWST, sucrose percentage, and purity were improved in the narrower row spacings, which were significantly better than in 28" spacing for both varieties.

Experiment 907

The roots of A90-MM, the globe-shaped beet, were similar to a table beet in growth habit with a large portion of the root growing above ground. They were somewhat difficult to harvest with the standard lifter wheels on the harvester as they tended to tilt to one side or the other rather than with straight vertical tops. By contrast, the SR87 line has roots that are conical- to top-shaped. The globe-shaped roots of A90-MM variety had excellent single crowns. It was apparent that the roots of the Univers variety had smaller grooves than the other commercial cultivars. Significant differences were observed for all of the characteristics that were measured (Table 2). The smooth root entries were significantly higher in root yield and recoverable sucrose per acre (RWSA) than the 2 check cultivars. The 5 entries fell into 3 groupings for sucrose percentage and recoverable sugar/ton (RWST). MHE4 and ACH176 were highest, Univers and SR87 were slightly lower, and A90-MM was significantly lower than the other 4 entries in the test. Univers and A90-MM were also significantly lower in purity than the commercial cultivars or SR87. Less soil was harvested with the globe-shaped roots than other varieties, but this was mainly because they grew so far out of the ground and had less surface area for soil to adhere to. At harvest the soil was saturated with moisture from recent rain storms,

and being of a heavy clay consistency, it clung to the roots even on smooth surfaces. Therefore, the data on soil adherence was considered not reliable and is not presented in Table 2. Since split or hollow crowns are somewhat characteristic for smooth root germplasm, we made observations for this characteristic in addition to collecting standard agronomic data. The percentage of plants with split or hollow crowns averaged 2, 5, 24, and 12%, respectively, for MHE4, ACH176, Univers, A90-MM, and SR87.

Table 1. Mean root and sugar yield sucrose percentage and clear juice purity percentage for MHE4 commercial cultivar and SR87 smooth root line grown at different row widths and plant densities. 1990. B&B Farm. (Exp 905)

		RWSA	T/A	RWST	Sucrose	CJP %
Row Spacing Means						
28"		5305	19.9	267.1	18.01	95.12
18"		5271	19.2	276.3	18.41	95.62
20"		5617	20.6	275.3	18.34	95.64
22"		5776	21.2	275.7	18.41	95.53
LSD (0.05)		331	1.3	4.9	0.25	0.28
Within Row Spacing Means						
12"		5561	20.6	271.1	18.21	95.28
6"		5424	19.8	276.1	18.38	95.68
sd		80	0.3	1.2	0.06	0.07
Row Spacing x Within Row Spacing Means						
28	12	5213	19.8	263.6	17.91	94.78
	6	5396	20.0	270.5	18.11	95.46
18	12	5621	20.5	275.5	18.42	95.48
	6	4921	18.0	277.1	18.41	95.76
20	12	5703	21.1	271.7	18.17	95.51
	6	5532	20.0	278.8	18.52	95.78
22	12	5706	21.1	273.6	18.33	95.35
	6	5847	21.3	277.9	18.48	95.72
LSD(0.05)		469	1.9	6.9	0.36	0.40
Variety Means						
	MHE4	5364	18.3	293.0	19.38	95.85
	SR87	5620	22.1	254.2	17.21	95.11
sd		80	0.3	1.2	0.06	0.07

Table 1. (continued)

Row Spacing x Variety Means

28	MHE4	5580	19.4	287.2	19.13	95.55
	SR87	5029	20.4	247.0	16.89	94.70
18	MHE4	4981	17.0	293.8	19.39	95.95
	SR87	5561	21.5	258.8	17.44	95.29
20	MHE4	5363	18.3	292.8	19.32	95.97
	SR87	5871	22.8	257.7	17.36	95.32
22	MHE4	5533	18.6	298.2	19.66	95.94
	SR87	6019	23.8	253.3	17.15	95.13
LSD(0.05)		663	2.7	9.8	0.51	0.57

Within Row Spacing x Variety Means

12	MHE4	5549	19.1	290.1	19.25	95.70
	SR87	5573	22.1	252.1	17.16	94.86
6	MHE4	5180	17.5	295.8	19.50	96.00
	SR87	5668	22.1	256.3	17.26	95.36
LSD(0.05)		469	1.9	6.9	0.36	0.40

Variety x Row Spacing x Within Row Spacing Means

28	12	MHE4	5608	19.8	283.8	18.96	95.43
		SR87	4818	19.8	243.4	16.86	94.13
	6	MHE4	5553	19.1	290.6	19.30	95.66
		SR87	5239	20.9	250.5	16.93	95.26
18	12	MHE4	5639	19.4	291.3	19.33	95.69
		SR87	5604	21.6	259.6	17.50	95.26
	6	MHE4	4323	14.6	296.2	19.45	96.20
		SR87	5519	21.4	258.0	17.38	95.32
20	12	MHE4	5464	18.9	289.1	19.15	95.82
		SR87	5941	23.4	254.4	17.19	95.20
	6	MHE4	5262	17.8	296.5	19.50	96.12
		SR87	5801	22.2	261.1	17.53	95.43
22	12	MHE4	5484	18.5	296.3	19.58	95.87
		SR87	5927	23.6	250.8	17.08	94.84
	6	MHE4	5583	18.6	300.0	19.75	96.02
		SR87	6110	23.9	255.8	17.21	95.41
LSD(0.05)			663	2.7	4.3	0.22	0.25
Grand Mean			5492	20.2	273.6	18.29	95.48

Table 2. Mean root and sugar yield sucrose percentage and clear juice purity percentage for 3 smooth root and 2 check varieties. 1990. B&B Farm (Exp. 907)

Variety	RWSA	T/Acre	RWST	Sugar	CJP %
MHE4	6117	22.3	274.4	18.47	95.15
ACH176	6796	23.5	288.7	19.40	95.06
UNIVERS	7263	30.0	242.6	16.87	93.90
A90-MM	5904	29.0	203.0	14.71	92.55
SR87	6688	27.9	239.2	16.56	94.18
LSD(0.05)	709	2.8	19.2	0.96	0.98
MEAN	6554	31.2	249.6	17.20	94.17

RHIZOCTONIA ROOT ROT EVALUATION FOR COMMERCIAL CULTIVARS AND EXPERIMENTAL HYBRIDS FOR MICHIGAN. USDA-ARS DISEASE NURSERY, EAST LANSING, MICHIGAN, 1990

J. C. Theurer, J. M. Halloin, and L. A. Hubble

A disease nursery to evaluate germplasm for Rhizoctonia root rot resistance is established each year at East Lansing. The disease nursery is maintained at the Botany Research Farm near the Michigan State University campus, using the same piece of land in a two-year rotation of sugarbeets on half of the land and alfalfa on the other half each year. This provides soil with a natural source innoculum of the Rhizoctonia solani disease organism. In addition, the sugarbeets in the nursery are innoculated by application of ground millet infected R. solani to the crowns of the beets about three weeks after thinning. Three varieties in the test were checks: #19, FC 907 and #20, 80B24-00 are resistant, and #18, Univers, is a European variety that is extremely susceptible to this disease. The roots were dug by hand in October and individually scored on a 0 to 4 scale where 0 = no lesions and 4 = dead. Disease average scores and the percent of crown rot is given in Table 1.

Table 1. 1990 Commercial Variety Rhizoctonia Evaluation, USDA Disease Nursery, East Lansing, MI.

Variety	Average Score*	% Crown Rot
1. Beta 5435	3.50 bcd†	87.56 abc
2. Beta 5315	2.86 cde	71.46 cde
3. Beta 5639	3.06 abcd	76.56 abcd
4. A-176	3.20 abcd	79.88 abcd
5. A-185	3.25 abcd	81.36 abcd
6. A-197	3.32 abcd	82.91 abcd
7. E4	3.33 abcd	83.19 abcd
8. E9	3.09 abcd	77.19 abcd
9. H23	3.65 ab	91.14 ab
10. A-85-452	3.12 abcd	77.91 abcd
11. A-86-1350‡	2.81 de	70.18 de
12. A-86-1353‡	1.95 fg	48.72 fg
13. Beta 4690‡	2.32 ef	57.91 ef
14. HM-LSR-88	3.23 abcd	80.84 abcd
15. Monohikari	3.50 abc	87.56 abc
16. HM 5135	3.40 abcd	84.96 abcd
17. A-85-153	3.01 bcd	75.30 bcd
18. Univers	3.71 a	92.75 a
19. FC 907 Check	1.60 g	40.01 g
20. 80B24-00 Check	2.37 ef	59.20 ef
Grand mean	3.01	75.33
LSD 0.05	0.55	13.75
CV	12.89	12.89

* Score based on 0 - 4 scale: 0 = no visible rot, 1 = light infection, 2 = moderate infection, 3 = severe infection, 4 = dead plant.

† Duncan's multiple range test. Means with same suffix letters are not significantly different at the 0.05 level.

‡ Rhizoctonia resistant commercial varieties.

GENOTYPE X NITROGEN RESPONSE

J. C. Theurer and J. W. Saunders

Nitrogen is an important element for stimulating early seedling growth and rapid development of the sugarbeet canopy. However, an excess of nitrogen fertilization can be very detrimental. Excess nitrogen reduces the margin of a grower's profit. High available soil N at the end of the growing season results in lower sucrose percentage in the taproot, and higher levels of impurities that interfere with sugar crystallization in the processing factory. Excessive nitrogen application can also be a problem in contamination of the soil and water.

Little is known about the basic genetic and biochemical causes for the nitrogen/sucrose inverse interaction. Most nitrogen rate studies have involved 1 or 2 commercial cultivars, and little work has been done to study the interaction of genotype x nitrogen. Research was initiated in 1989 to investigate further the genotype x nitrogen-sucrose concentration relationship, with a goal to identify some of the basic genetic factors governing these interactions.

Two field experiments were conducted in 1990. One experiment was set up to evaluate high sugar lines to see if there was significant variation for nitrogen response. In the second experiment we evaluated a group of today's current high sugar commercial hybrid cultivars for nitrogen response and residual amino nitrogen in the root at harvest.

Materials and Methods

Experiment 903

Seven diverse, high sugar lines and 3 commercial varieties, MHE4, ACH 185, and Ultramono, were planted in a 3-replication randomized block experiment on May 2, 1990. Individual plots were 2 rows 28" apart and 28'long. Prior to planting, composite soil samples at 1', 2', and 3' depths were taken to the soils laboratory at Michigan State University and analyzed for plant nutrients. No fertilizer was applied to the land preplant or at the time of planting. After thinning, during the first week of June, 4 fertilizer treatments were applied to the experiment by careful hand broadcasting between plant rows. A uniform application of 60# phosphate/acre was applied over the experiment. Each nitrogen treatment was applied across a block within each replication. Four buffer rows of MHE4 were used to border the fertilizer blocks. Nitrogen rates were 0, 60, 120, and 180 lbs. of actual N/acre. The experiment was harvested by machine on October 30, and a 15-beet sample from each plot was taken for laboratory analyses of sucrose percent, clear juice purity, and residual amino nitrogen.

Experiment 904

Eleven commercial hybrids and 3 experimental hybrids were planted May 2, 1990, in 3 replications of a randomized block field test. Prior to planting, a soil sample was taken and analyzed for nutrients as cited above for Experiment 903. Experiment 904 was grown on land adjacent to Experiment 903 and subsequently fertilized in the same manner and at the same rates as cited above. Harvest was made on October 30, and a 15-beet sample was taken for

lab analyses. Brei samples were also taken and frozen for later studies on protein as in Experiment 903.

Results

Experiment 903

The composite soil sample taken prior to planting indicated a residual soil N content of 6.7 ppm at the 1', 6.9 ppm at 2', and 5.7 ppm at 3' depth. Plants in the 0 nitrogen treatment showed yellowing of leaves in August, while plants at the 180# N level had a dark green color during the growing season, up until harvest. The analyses of variance indicated that there were significant differences in the effects of the nitrogen treatments, and of the varieties for all parameters studied. All parameters except RWSA responded unidirectionally with increasing N level in general in accordance with established patterns (Tables 1 and 2). RWSA responded with a peak at 120# N. Thus root weight and amino N increased and RWST and sucrose percentage and clear juice purity % decreased, with increasing N. However, the nitrogen x variety interaction was significant for only tons per acre and RWSA. Ultramono had high root yield regardless of N level. Similarly, A3952, F1010, C40, and the 4N Polish line showed no significant tonnage response with added increments of N. ACH-185 and MHE4, both commercially grown in Michigan, increased yield with N treatments over the 0 level, but yield at the other increments of N were similar. The root yield of L19 was significantly higher at 180# N/acre than at the 60 and 120# rates. At high N levels, L19 also demonstrated the most sensitive response of all the entries in deterioration of sucrose percentage and the increase of amino N in the root at harvest. L19, ACH-185, and F1010 at the 0 nitrogen treatment had the highest sucrose percent. ACH-185 at 180# N was unique in that the sugar percent was about the same as for the 0 level. The 550 inbred also showed stability in sucrose percentage over N levels. A3952 was the only variety that exhibited poor vigor and it had low sucrose regardless of the N treatment. The quantity of amino nitrogen in the taproot at harvest was the only one of the six parameters measured wherein all of the varieties responded significantly in the same direction; amino N increased significantly with each increased increment of N. There were also significant differences between entries in amino N at harvest. L19, A3952, and C51 high sugar lines were highest in amino N. An interesting observation was that L19 had the highest sugar percentage and also the highest amino N content of all of the entries in the experiment.

Experiment 904

The composite soil sample taken prior to planting for the soil where this experiment was planted indicated a residual nitrate N content of 13.3 ppm at the 1', 10.6 ppm at 2', and 8.7 ppm at 3' depth. Plants in this test were similar to those in 903 in that the 0 nitrogen treatment showed yellowing of leaves in August, while plants at the 180# N level had a dark green color during the growing season. The analyses of variance indicated that there were significant differences in the effects of the nitrogen treatments, and the varieties for all variables studied. Root weight (tons/acre) was significantly increased with each added increment of N with a 6.8 ton difference between 0 versus 180# N (Tables 3 and 4). However, there were no differences in the RWSA between 60# to 180# N. Sugar percentage and RWST was optimum at the 60# N fertilizer rate. Clear juice purity decreased significantly and the amino N in the taproots increased significantly for all

varieties as nitrogen was increased. The experimental variety, EL 36 CMS x (Clones 2-101 x 80-79) and HMI 5135 had the highest root weight. HMI 5135 was also highest in RWSA, with MH E4 as the lowest in RWSA. Beta 5315 and ACH hybrids had the highest RWST and sucrose percentage, whereas the EL experimental hybrids had significantly the lowest values for these traits. Two high yield experimental hybrids had significantly the highest residual amino N levels. Beta 5315, ACH 85-153, Monohikari, and MH E4 had the lowest amino N content in the taproots.

The nitrogen x variety interaction was significant only for clear juice purity and amino nitrogen content of the root. The variety ACH 185 and the experimental hybrid EL 36 x (clone 1-102 x 80-79) showed no difference in purity between N levels. All varieties were significantly higher in purity at the 0 rate compared with the 180# treatment. Monohikari, KW 1119, and HMI 5135 had no differences between 0, 60, and 120#/acre N, but were significantly high in impurities at the 180# rate. Varieties ACH 87-353, KW 1119, KW2389, HMI 5135, and one experimental hybrid tended to show significant increases in amino N with each increased increment in N. All varieties had significantly greater amino N at the 180# rate than at the 0 level, and most varieties were also significantly higher at the 120# rate.

Table 1. Means by nitrogen level, variety and nitrogen level x variety for root and sugar yield, RWST, sucrose percent, clear juice purity percent and meq/l Amino N. (1990. Exp 903 - High Sugar Lines)

Nitrogen Level	RWSA	T/ACRE	RWST	Sucrose	CJP %	Amino N
0	5955	21.8	274.4	18.73	94.43	142.3
60	6189	24.1	258.2	17.84	94.00	174.3
120	6624	25.9	256.9	17.89	93.64	230.8
180	6259	26.3	238.5	16.87	93.10	275.4
LSD (0.05)	385	1.1	9.7	0.57	0.33	23.9

Varieties	RWSA	T/A	RWST	Sucrose	CJP %	Amino N
MHE4	6461	27.0	239.9	16.62	94.13	179.6
L19 SELECT	6277	23.8	266.4	18.57	93.46	257.1
ACH185	7257	26.3	277.3	18.98	94.26	185.2
A3952	5894	26.2	224.9	16.10	92.73	251.4
ULTRAMONO	7600	30.4	250.7	17.49	93.61	214.0
C40	6430	24.8	260.5	18.14	93.59	195.9
C51	5743	22.7	255.9	17.93	93.33	250.4
89EL550	3369	12.8	264.5	18.09	94.45	191.1
4NPOLISH	6911	26.4	261.9	18.04	94.08	161.5
F1010	6624	24.8	268.1	18.37	94.29	175.2
LSD (0.05)	609	1.9	15.4	0.91	0.52	37.8
0 MHE4	5554	21.6	256.8	17.44	94.91	130.0
L19SELECT	6241	21.2	295.0	20.09	94.35	146.3

Table 1. (Continued)

Nitrogen Level	Variety	RWSA	T/A	RWST	Sucrose	CJP %	Amino N
	ACH185	6432	22.0	292.6	19.78	94.72	124.3
	A3952	5544	24.5	225.3	16.06	93.00	206.0
	ULTRAMONO	7701	27.9	276.2	18.79	94.57	151.7
	C40	6674	24.1	278.0	18.90	94.56	128.7
	C51	4821	16.8	286.6	19.57	94.27	146.0
	89EL550	2572	9.4	274.5	18.60	94.80	136.0
	4NPOLISH	7340	26.4	279.1	18.99	94.54	118.3
	F1010	6667	23.7	280.2	19.04	94.59	141.0
Mean		5954	21.8	274.4	18.7	94.4	142.8
60	MHE4	5781	25.8	224.1	15.76	93.65	147.7
	L19SELECT	5942	22.0	268.8	18.62	93.77	196.3
	ACH185	6706	25.6	263.9	17.95	94.72	153.3
	A3952	6468	26.4	244.7	17.31	93.05	237.0
	ULTRAMONO	7236	30.9	234.1	16.47	93.49	209.3
	C40	6537	23.4	280.1	19.27	93.96	152.7
	C51	5833	23.8	245.2	17.22	93.45	222.7
	89EL550	3267	12.4	263.4	17.97	94.60	161.0
	4NPOLISH	7030	25.6	273.7	18.55	94.77	115.0
	F1010	7090	25.0	283.8	19.31	94.49	147.7
Mean		6189	24.1	258.2	17.8	94.0	174.3
120	MHE40	6899	29.5	235.4	16.30	94.23	179.3
	L19SELECT	6560	23.9	274.9	19.34	92.95	338.0
	ACH185	8065	28.7	280.4	19.22	94.15	210.7
	A3952	5997	26.3	228.7	16.35	92.80	274.3
	ULTRAMONO	8141	31.5	257.7	17.96	93.62	215.7
	C40	6669	27.5	242.7	17.35	92.61	223.7
	C51	6678	25.4	263.3	18.48	93.23	304.0
	89EL550	3741	14.2	263.6	18.03	94.46	215.0
	4NPOLISH	7160	27.2	262.3	18.09	94.06	181.0
	F1010	6328	24.4	259.8	17.82	94.34	166.3
Mean		6623	25.9	256.9	17.9	93.6	230.8
180	MHE4	7609	31.2	243.4	17.00	93.72	261.3
	L19SELECT	6365	28.0	226.8	16.23	92.77	347.7
	ACH185	7825	28.8	272.1	18.97	93.43	252.3
	A3952	5568	27.7	201.1	14.69	92.06	288.3
	ULTRAMONO	7320	31.1	234.9	16.75	92.75	279.3
	C40	5839	24.1	241.1	17.01	93.25	266.7
	C51	5640	24.8	228.4	16.46	92.36	329.0
	89EL550	3897	15.2	256.4	17.76	93.93	252.3
	4NPOLISH	6115	26.3	232.4	16.53	92.97	231.7
	F1010	6413	25.9	248.7	17.32	93.73	245.7
Mean		6259	26.3	238.5	16.9	93.1	275.4
LSD (0.05)		1218	3.8	30.87	1.82	1.04	75.6
Grand Mean		6256	24.5	257.0	17.83	93.79	205.8
CV		12	9.4	7.4	6.29	0.68	22.6

Table 2. Variety x Nitrogen Treatment Means for high sugar lines. 1990. B&B Farm. (Exp. 903)

Variety	RWSA	T/Acre	RWST	Suc %	CJP %	Amino N	N #
1	5553.8	21.6	256.8	17.4	94.9	130.0	0
	5781.3	25.8	224.1	15.8	93.7	147.7	60
	6899.1	29.5	235.4	16.3	94.2	179.3	120
	7608.8	31.2	243.4	17.0	93.7	261.3	180
2	6241.4	21.2	295.0	20.1	94.3	146.3	0
	5941.8	22.0	268.8	18.6	93.8	196.3	60
	6559.9	23.9	274.9	19.3	92.9	338.0	120
	6364.7	28.0	226.8	16.2	92.8	347.7	180
3	6432.2	22.0	292.6	19.8	94.7	124.3	0
	6706.3	25.6	263.9	18.0	94.7	153.3	60
	8065.2	28.7	280.4	19.2	94.1	210.7	120
	7825.5	28.8	272.1	19.0	93.4	252.3	180
4	5543.7	24.5	225.3	16.1	93.0	206.0	0
	6467.6	26.4	244.7	17.3	93.1	237.0	60
	5996.8	26.3	228.7	16.3	92.8	274.3	120
	5567.7	27.7	201.1	14.7	92.1	288.3	180
5	7701.3	27.9	276.2	18.8	94.6	151.7	0
	7236.4	30.9	234.1	16.5	93.5	209.3	60
	8140.7	31.5	257.7	18.0	93.6	215.7	120
	7320.0	31.1	234.9	16.8	92.8	279.3	180
6	6674.3	24.1	278.0	18.9	94.6	128.7	0
	6536.8	23.4	280.1	19.3	94.0	152.7	60
	6669.1	27.5	242.7	17.3	92.6	223.7	120
	5839.5	24.1	241.1	17.0	93.2	266.7	180
7	4820.7	16.8	286.6	19.6	94.3	146.0	0
	5832.7	23.8	245.2	17.2	93.5	222.7	60
	6677.7	25.4	263.3	18.5	93.2	304.0	120
	5640.5	24.8	228.4	16.5	92.4	329.0	180
8	2572.3	9.4	274.5	18.6	94.8	136.0	0
	3266.6	12.4	263.4	18.0	94.6	161.0	60
	3741.3	14.2	263.6	18.0	94.5	215.0	120
	3897.3	15.2	256.4	17.8	93.9	252.3	180
9	7340.1	26.4	279.1	19.0	94.5	118.3	0
	7030.2	25.6	273.7	18.6	94.8	115.0	60
	7160.0	27.2	262.3	18.1	94.1	181.0	120
	6114.9	26.3	232.4	16.5	93.0	231.7	180
10	6666.7	23.7	280.2	19.0	94.6	141.0	0
	7090.4	25.0	283.8	19.3	94.5	147.7	60
	6327.6	24.4	259.8	17.8	94.3	166.3	120
	6412.8	25.9	248.7	17.3	93.7	245.7	180

Table 2. (Continued)

Variety	RWSA	T/Acre	RWST	Suc %	CJP %	Amino N	N #
Grand Mean	6189.0	24.1	258.2	17.8	94.0	174.3	
LSD (0.05)	1218.0	3.8	31.0	1.8	1.04	71.01	

Table 3. Means by nitrogen level and variety for sugar yield, root yield, RWST, sucrose percent, clear juice purity percent and meq/l Amino N. 1990. B&B Farm. (Exp 904 - High sugar commercial cultivars)

Nitrogen Level		RWSA	T/A	RWST	Sugar %	CJP %	Amino N
0		5783	20.7	280.8	18.82	95.30	89.7
60		7086	25.1	283.8	19.11	95.00	118.6
120		7152	26.4	271.3	18.45	94.63	144.7
180		7230	27.5	264.3	18.19	94.13	190.5
LSD (0.05)		288.5	0.9	6.96	0.43	0.15	9.16
Varieties							
MHE4	1	6272	23.2	271.1	18.33	94.96	122.2
ACH185	2	7000	24.7	284.6	19.21	94.90	127.0
ACH85-153	3	6991	23.9	293.8	19.68	95.16	116.9
ACH87-353	4	6677	22.9	291.8	19.64	94.93	132.7
ACH85-323	5	6664	23.1	289.8	19.67	94.56	132.3
ACH84-600	6	6848	24.6	279.3	18.96	94.67	143.3
MONOHIKARI	7	7159	26.6	269.5	18.21	95.00	118.3
KW1119	8	7107	25.6	279.6	18.88	94.88	146.0
KW2398	9	7144	25.2	283.7	19.11	95.00	133.5
HMI5135	10	7465	26.9	277.8	18.87	94.64	141.0
BETA5315	11	6528	22.0	298.0	19.96	95.15	111.3
EC36X Z*	12	6802	28.4	240.3	16.64	94.13	167.2
576X Z*	13	6337	25.5	247.8	16.93	94.75	140.5
86S1	14	6384	26.3	243.4	16.90	93.98	170.2
LSD (0.05)		539.7	1.64	13.03	0.81	0.28	17.14

*Z = 86B2R5/6 (2-101/80-79)

Nitrogen Level x Variety							
0	1	5490	19.3	284.0	18.83	95.82	80.7
	2	5937	20.4	292.1	19.61	95.07	90.7
	3	5689	18.7	304.9	20.24	95.55	71.0
	4	4786	16.4	288.2	19.38	95.05	96.7
	5	5449	18.6	295.0	19.78	95.11	93.0
	6	6579	22.6	292.4	19.55	95.28	95.0

Table 3. (Continued)

	7	6325	23.3	271.0	18.11	95.56	78.0
	8	5683	19.2	295.2	19.71	95.34	96.0
	9	6422	22.2	289.9	19.29	95.56	80.0
	10	6743	23.3	288.8	19.38	95.15	109.0
	11	5317	17.9	298.8	19.85	95.56	71.3
	12	6218	24.3	256.0	17.37	94.97	113.7
	13	4826	21.4	225.8	15.31	95.51	83.3
	14	5494	22.1	248.9	17.04	94.62	97.7
Mean		5782	20.7	280.8	18.8	93.3	89.7
60	1	6408	22.8	281.6	19.03	94.85	104.3
	2	7070	23.9	295.9	19.80	95.21	117.7
	3	7351	24.0	306.3	20.34	95.50	104.7
	4	7289	23.7	308.2	20.46	95.49	108.7
	5	7042	23.4	301.6	20.41	94.58	125.3
	6	6735	23.9	282.4	19.10	94.81	130.0
	7	7323	26.6	275.5	18.54	95.15	101.3
	8	7728	26.1	296.1	19.77	95.33	114.3
	9	7677	27.0	284.6	19.19	94.96	117.3
	10	7299	26.5	275.2	18.61	94.89	113.0
	11	6957	22.4	310.7	20.66	95.40	96.0
	12	6575	27.6	238.0	16.47	94.25	149.7
	13	6981	26.1	268.0	18.11	95.03	126.7
	14	6773	27.2	248.5	17.04	94.54	151.0
Mean		7086	25.1	283.8	19.1	95.0	118.6

	RWSA		T/A	RWST	Sugar %	CJP %	Amino N
120	1	6215	24.4	255.1	17.46	94.57	131.3
	2	7090	25.9	273.5	18.57	94.70	134.0
	3	7421	26.0	286.4	19.32	94.88	132.0
	4	7284	24.7	295.4	19.93	94.80	140.7
	5	7081	25.0	282.9	19.20	94.66	140.3
	6	6532	24.3	268.1	18.33	94.43	169.3
	7	7326	26.5	275.4	18.51	95.21	113.7
	8	6998	27.4	255.1	17.36	94.80	165.0
	9	8325	28.6	291.6	19.59	95.05	134.0
	10	7929	28.1	282.0	19.11	94.72	140.7
	11	7029	24.2	289.7	19.60	94.72	130.0
	12	7338	30.5	240.2	16.69	94.00	175.0
	13	6795	26.9	252.3	17.27	94.59	141.7
	14	6770	27.1	249.8	17.41	93.72	178.0
Mean		7152	26.4	271.3	18.3	94.6	144.7

Table 3. (Continued)

180	1	6977	26.4	263.8	17.99	94.60	172.3
	2	7904	28.5	277.0	18.84	94.61	165.7
	3	7504	27.1	277.6	18.84	94.70	160.0
	4	7348	26.7	275.3	18.81	94.38	184.7
	5	7085	25.3	279.7	19.28	93.89	170.3
	6	7547	27.5	274.5	18.84	94.15	178.7
	7	7661	29.9	256.1	17.69	94.07	180.3
	8	8020	29.5	271.8	18.70	94.06	208.7
	9	6151	23.1	268.7	18.37	94.42	202.7
	10	7888	29.8	265.0	18.37	93.78	201.3
	11	6810	23.3	293.0	19.73	94.91	148.0
	12	7079	31.2	226.8	16.04	93.31	230.3
	13	6747	27.5	244.9	17.04	93.87	210.3
	14	6499	28.7	226.6	16.12	93.05	254.0
Mean		7229	27.5	264.3	18.2	94.1	190.5
cv		10	8.4	5.8	5.37	0.36	15.6
Grand Mean		6813	24.9	275.0	18.64	94.76	135.8
LSD (0.05)		1079	3.37	26.1	1.62	.56	34.2

Table 4. Variety x Nitrogen Treatment Means for hybrid varieties. B&B Farm. 1990. (Exp. 904)

Variety	RWSA	T/Acre	RWST	SUC %	CJP %	Amino N	N #
1	5489.6	19.3	284.0	18.8	95.8	80.7	0
	6407.9	22.8	281.6	19.0	94.9	104.3	60
	6215.3	24.4	255.1	17.5	94.6	131.3	120
	6976.6	26.4	263.8	18.0	94.6	172.3	180
2	5937.1,	20.4	292.1	19.6	95.1	90.7	0
	7069.8	23.9	295.9	19.8	95.2	117.7	60
	7090.0	25.9	273.5	18.6	94.7	134.0	120
	7904.1	28.5	277.0	18.8	94.6	165.7	180
3	5688.7	18.7	304.9	20.2	95.6	71.0	0
	7351.4	24.0	306.3	20.3	95.5	104.7	60
	7421.3	26.0	286.4	19.3	94.9	132.0	120
	7503.6	27.1	277.6	18.8	94.7	160.0	180
4	4785.8	16.4	288.2	19.4	95.0	96.7	0
	7288.8	23.7	308.2	20.5	95.5	108.7	60
	7284.1	24.7	295.4	19.9	94.8	140.7	120
	7347.7	26.7	275.3	18.8	94.4	184.7	180

Table 4. (Continued)

5	5449.1	18.6	295.0	19.8	95.1	93.0	0
	7042.4	23.4	301.6	20.4	94.6	125.3	60
	7080.8	25.0	282.9	19.2	94.7	140.3	120
	7085.4	25.3	279.7	19.3	93.9	170.3	180
6	6578.8	22.6	292.4	19.6	95.3	95.0	0
	6735.4	23.9	282.4	19.1	94.8	130.0	60
	6532.2	24.3	268.1	18.3	94.4	169.3	120
	7547.4	27.5	274.5	18.8	94.1	178.6	180
7	6325.3	23.3	271.0	18.1	95.6	78.0	0
	7322.8	26.6	275.5	18.5	95.1	101.3	60
	7325.9	26.5	275.4	18.5	95.2	113.7	120
	7660.6	29.9	256.1	17.7	94.1	180.3	180
8	5683.2	19.2	295.2	19.7	95.3	96.0	0
	7727.5	26.1	296.1	19.8	95.3	114.3	60
	6998.3	27.4	255.1	17.4	94.8	165.0	120
	8020.3	29.5	271.8	18.7	94.1	208.7	180
9	6422.1	22.2	289.9	19.3	95.6	80.0	0
	7677.2	27.0	284.6	19.2	95.0	117.3	60
	8324.7	28.6	291.6	19.6	95.0	134.0	120
	6150.9	23.1	268.7	18.4	94.4	202.7	180
10	6743.4	23.3	288.8	19.4	95.2	109.0	0
	7298.5	26.5	275.2	18.6	94.9	113.0	60
	7929.4	28.1	282.0	19.1	94.7	140.7	120
	7887.9	29.8	265.0	18.4	93.8	201.3	180
11	5317.0	17.8	298.8	19.9	95.6	71.3	0
	6956.9	22.4	310.7	20.7	95.4	96.0	60
	7029.2	24.2	289.7	19.6	94.7	130.0	120
	6809.7	23.3	293.0	19.7	94.9	148.0	180
12	6218.0	24.3	256.0	17.4	95.0	113.7	0
	6574.7	27.6	238.0	16.5	94.2	149.7	60
	7337.9	30.5	240.2	16.7	94.0	175.0	120
	7078.6	31.2	226.8	16.0	93.3	230.3	180
13	4825.7	21.4	225.8	15.3	95.5	83.3	0
	6981.4	26.1	268.0	18.1	95.0	126.7	60
	6795.3	26.9	252.3	17.3	94.6	141.7	120
	6747.2	27.5	244.9	17.0	93.9	210.3	180
14	5494.2	22.1	248.9	17.0	94.6	97.7	0
	6773.0	27.2	248.5	17.0	94.5	151.0	60
	6769.8	27.1	249.8	17.4	93.7	178.0	120
	6498.8	28.7	226.6	16.1	93.1	254.0	180
Grand Mean	6813.0	24.9	275.0	18.6	94.8	135.8	
LSD (0.05)	1078	3.4	26.1	1.6	0.6	34.2	

CROPPING SYSTEMS AND FIBROUS ROOT GROWTH OF SUGARBEET AT 14 IN. AND 22 IN. PLANT SPACINGS

A.J.M. Smucker and J. C. Theurer

A research project at Michigan State University has been established to study resource efficient cropping systems for dry bean and sugarbeet production. As a part of this study, an experiment was conducted in 1990 at the Dorr Farm near Saginaw, MI to evaluate MHE-4 commercial variety and SR87 smooth root variety in 14-in. and 22-in. row spacings under different cropping systems.

Sugar beet varieties MHE-4 and SR87 were planted at 14- and 22-in. row spacings on May 8, 1990. Previous crops included oats, half of which was underseeded with clover in 1989. There was an excellent stand of clover and the oat crop was good. Following the oat harvest the clover crop was grown until mid-September, when half of the previous crop was subsoiled to a depth of 16 in. The entire experimental area was fall plowed and a triple K secondary tillage was applied to the entire experiment before planting, using controlled wheel traffic at 7-ft. intervals. No herbicides were applied to the experiment. Plants were manually thinned to 8-in. spacings during the first week of June, resulting in an excellent population of sugarbeet plants across the entire experiment for the duration of the experiment. Complete weed control was achieved manually. Plots were replicated four times.

Minirhizotron tubes, 3 per plot, were installed at 45 degrees and to depths of 120 cm immediately after planting by a modified Giddings hydraulic probe. Video recordings of roots intercepting the upper surfaces of each tube were taken at 14- to 16-day intervals beginning after the thinning of the experiment. Plant samples were taken in August and the experiment was harvested during the first week in October. Smaller, 10 ft. samples were harvested over the minirhizotron tubes and larger, 50 ft. samples, were harvested by machine away from the root observation tubes. Analyses for sugar and quality were completed following harvest.

Root yields and sugar production (RWSA) at harvest responded significantly to subsoil tillage, row spacing and variety. Clover had no significant influence on these parameters. There were several significant interaction effects on the yield and RWSA. Clover underseeding for less than one year significantly reduced both root yield and RWSA (Table 1).

Subsoil tillage appeared to overcome the negative effects of clover on root yield but could not ameliorate these effects on RWSA per acre. Subsoil tillage generally lowered yields when clover was the previous crop, yet RWSA was greater on subsoiled treatments (Table 2). Clover reduced yields and RWSA for both varieties and subsoiled sugarbeets. Again subsoil treatments appeared to ameliorate the negative effects of clover on the yield and RWSA of MHE-4 (Table 2).

Row spacings of 14 in. summed across treatments had significantly greater root yield, RWSA, RWST, sucrose, and clear juice purity (CJP) than 22 in. spacings (Table 3). In other experiments, we have observed opposite or non-significant differences in root yield of 14-in. vs. 22-in. and would not

recommend 14-in. spacing for a commercial crop. However, row spacing continues to have the most significant influence on sugarbeet production and quality. Reducing row spacing from the standard 28-in. to 22-in. rows appears to be the best and most feasible management change for increasing sugarbeet production in Michigan.

The smooth root variety (SR87) yielded more than MHE-4 for all treatments (Tables 2 and 4). However, the sucrose content in SR87 was lower resulting in lower RWSA for this variety. There was a significant subsoil tillage by variety interaction which indicates that deep tillage increases the yield of MHE-4 with little effect on the smooth root variety (Table 4). Yield of the variety MHE-4 was reduced to 24.1 T/a when clover was the previous crop if sugarbeets were planted at 14 in. row spacing in the absence of deep tillage (Table 5).

The presence of plastic minirhizotron tubes influenced the yields of sugarbeets very little. However, there was a curious reduction in the RWSA produced by sugarbeets grown over the tubes in contrast to the 2500 - 2800 more pounds of sugar by plants grown separate from the tubes (Table 5). These preliminary data suggest that more of the sugarbeet taproots may have branched when they contacted the root observation tubes as greater root branching generally reduces RWSA contents.

Sugar production appeared to be influenced by the growth rates and longevity of root growth. The 14-in. row spacings increased the growth of fibrous roots in the top 20 cm of soil during the period from 44-59 DAP, Fig. 1. There was more root growth in the 0 to 100 cm areas of the soil profiles of the narrower rows from 59-77 DAP. There were no differences in root activities for the two row spacings for the period from 86-101 DAP.

The smooth root variety of sugarbeets, SR87, appeared to produce fewer roots in the 40-100 cm region of the soil during the period from 44-59 DAP, Fig. 2. However, as the season progressed, the smooth root variety produced more roots than the commercial variety, MHE-4, in the 40-100 cm region of the soil profile at 59-77 DAP. Death rates during the drought period from 77-86 DAP, appeared to be similar for both varieties. There were no differences in root activities for the two row spacings for the period from 86-101 DAP.

Subsoil tillage treatments began to influence root activities from the period from 59-77 DAP, Fig. 3. Deep tillage appeared to enhance root growth in the soil profile at depths greater than 30 cm. Subsoiling also reduced the death rates of the fibrous sugarbeet roots during the drought period from 77-86 DAP. This significant reduction in root death rates at 10-30 and 90-110 cm may have been the primary reason for the significant increases in the yields of all sugarbeet treatments which included subsoil tillage, Table 4. Again, subsoil tillage had little to no influence on root turnover rates for the period from 86-101 DAP.

When clover was the previous crop, sugarbeet fibrous root growth was reducedain the upper 25 cm, increased at the 30-70 cm depths and decreased from 80-100 cm 44-59 days after planting (DAP), Fig. 4. This trend continued through 77 DAP. Root death was much greater on the clover plots at soil depths from 20-110 cm during the period from 77-86 DAP. Clover treatments had little effect on the root turnover rates for the period from 86-101 DAP.

The yield of the SR87 variety, showing a root system tolerant to drought when planted at 14-in. row spacings on the subsoiled treatments of the Parkhill soils of this experiment (Tables 2 and 3), is additional evidence that strategic soil and crop management systems will greatly improve and sustain plant production systems in the Saginaw Valley of Michigan. These data demonstrate the importance of quantifying the dynamics of fibrous sugarbeet roots, especially during periods of soil moisture deficits. It is essential to strategically coordinate subsoil tillage with plant varieties having responsive and plastic root systems, which rapidly respond or are resistant to environmental stresses before we can make significant progress in stress tolerances. Once more sucrose is incorporated into the smooth root variety and more is known regarding the root dynamics of this variety, during periods of short drought, the RWSA should increase substantially.

Table 1. Influence of clover unersown into oats and subsoiling to a depth of 15 in. on the yield, recoverable white sugar per acre (RWSA), RWST (ton) and clear juice purity (CJP) of sugarbeets on a Parkhill loam, Door Farm, 1990.

Clover	Subsoil	Yield T/a	RWSA lbs.	RWST lbs.	CJP %
-	-	28.4 a	7347 ab	259.8 a	95.5 a
-	+	29.7 a	7699 a	260.9 a	95.4 a
	Average	29.0	7523	260.4	95.5
+	-	26.9 b	6971 b	260.3 a	95.3 a
+	+	29.2 a	7213 b	247.8 b	94.7 b
	Average	28.0	7092	254.0	95.0
Standard deviation		0.37	136	2.4	0.07

Values in each column followed by the same letter are not significantly different according to Duncan's multiple range test at 0.05.

Table 2. Influence of oats undersown by clover, subsoiling, and variety on the yield, recoverable white sugar per acre (RWSA), sucrose and clear juice purity of sugarbeets grown on a Parkhill loam, Dorr Farm, 1990.

Clover	Subsoil	Variety	Yield T/a	RWSA lbs./a	Sucrose %	CJP %
-	-	MHE-4	26.9 d	7526 ab	18.5 ab	96.0 a
-	-	SR87	30.0 ab	7168 bc	16.4 c	94.9 b
-	+	MHE-4	27.7 cd	7798 a	18.7 a	95.7 a
-	+	SR87	31.6 a	7600 ab	16.3 c	95.2 b
		Average	29.0	7522	17.5	95.4
+	-	MHE-4	24.6 e	6914 c	18.7 a	95.9 a
+	-	SR87	29.3 bc	7027 bc	16.4 c	94.8 b
+	+	MHE-4	28.3 bcd	7640 ab	18.2 b	95.1 b
+	+	SR87	30.0 ab	6786 c	15.7 d	94.3 c
		Average	28.0	7092	17.2	95.0
Standard deviation (Sd)			0.66	196	0.15	0.15

Values in each column followed by the same letter are not significantly different according to Duncan's multiple range test at 0.05.

Table 3. Influence of row spacing on the yield, recoverable white sugar, sucrose and clear juice purity of sugarbeets grown on a Parkhill loam, Door Farm, 1990.

Row Spacing	Yield T/a	RWSA lbs./a	RWST lbs./T	Sucrose %	CJP %
22"	27.2	6906	255.5	17.3	95.2
14"	29.9	7709	258.9	17.4	95.3
Standard deviation	0.3	98	1.3	0.1	0.1

Table 4. Influence of subsoiling to 16 in. and row spacing on the yield and recoverable white sugar per acre (RWSA), sucrose and clear juice purity (CJP) of sugarbeets grown on a Parkhill loam, Dorr Farm, 1990.

Subsoil	Variety	Yield T/a	RWSA lbs./a	Sucrose %	CJP %
-	MHE-4	25.7 c	7220 b	18.6	95.9
-	SR87	29.6 a	7097 b	16.4	94.9
+	MHE-4	28.0 b	7719 a	18.5	95.4
+	SR87	30.8 a	7193 b	16.0	94.7
Standard deviation		0.47	138	0.10	0.11

Values in each column followed by the same letter are not significantly different according to Duncan's multiple range test at 0.05.

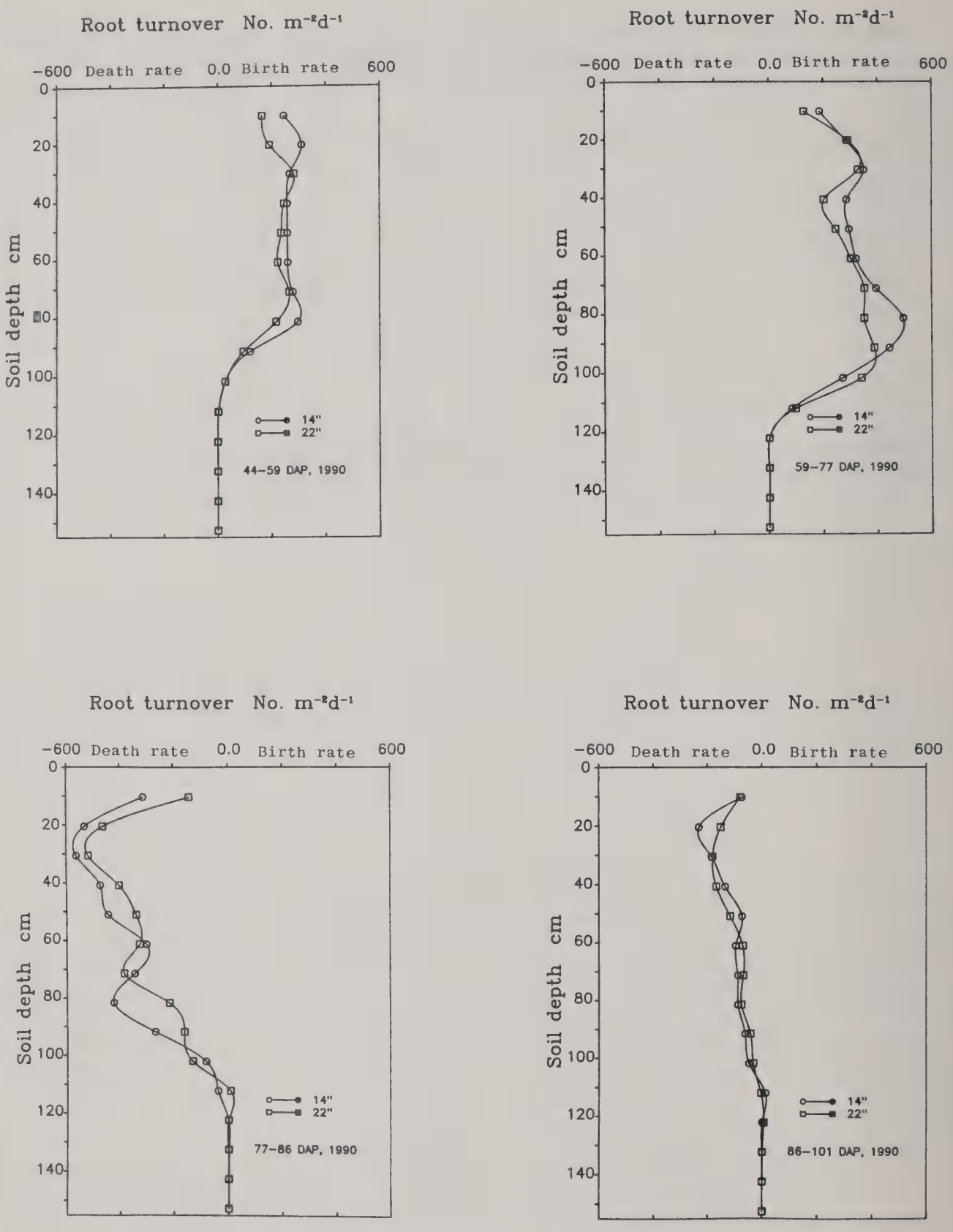

Fig. 1. Root dynamics of sugarbeets from 44-101 DAP 14 and 22 inch row spacings in a Parkhill loam soil, Dorr Farm, 1990

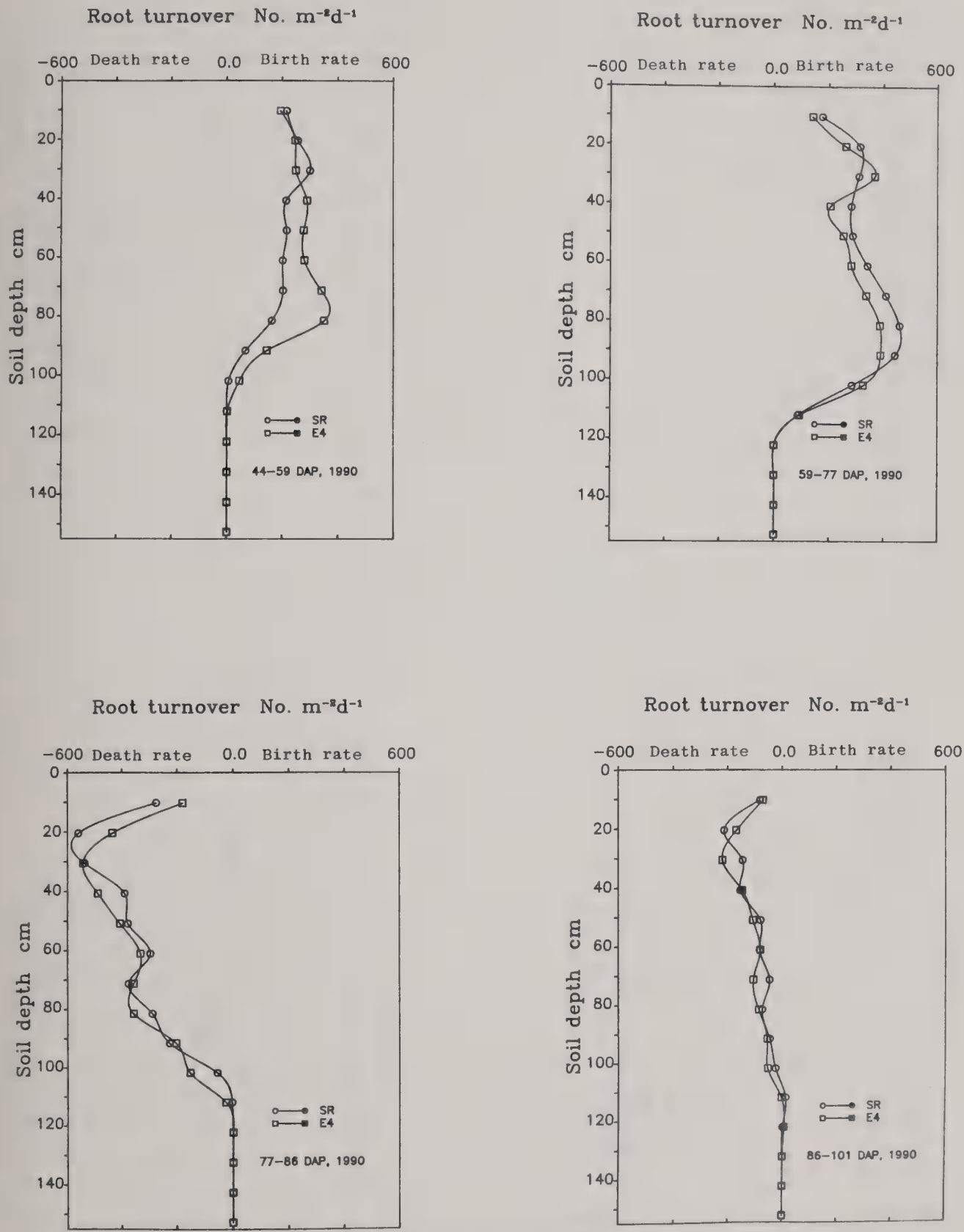

Fig. 2. Root dynamics of sugarbeet varieties from 44-101 DAP at two row spacings in a Parkhill loam soil, Dorr Farm, 1990

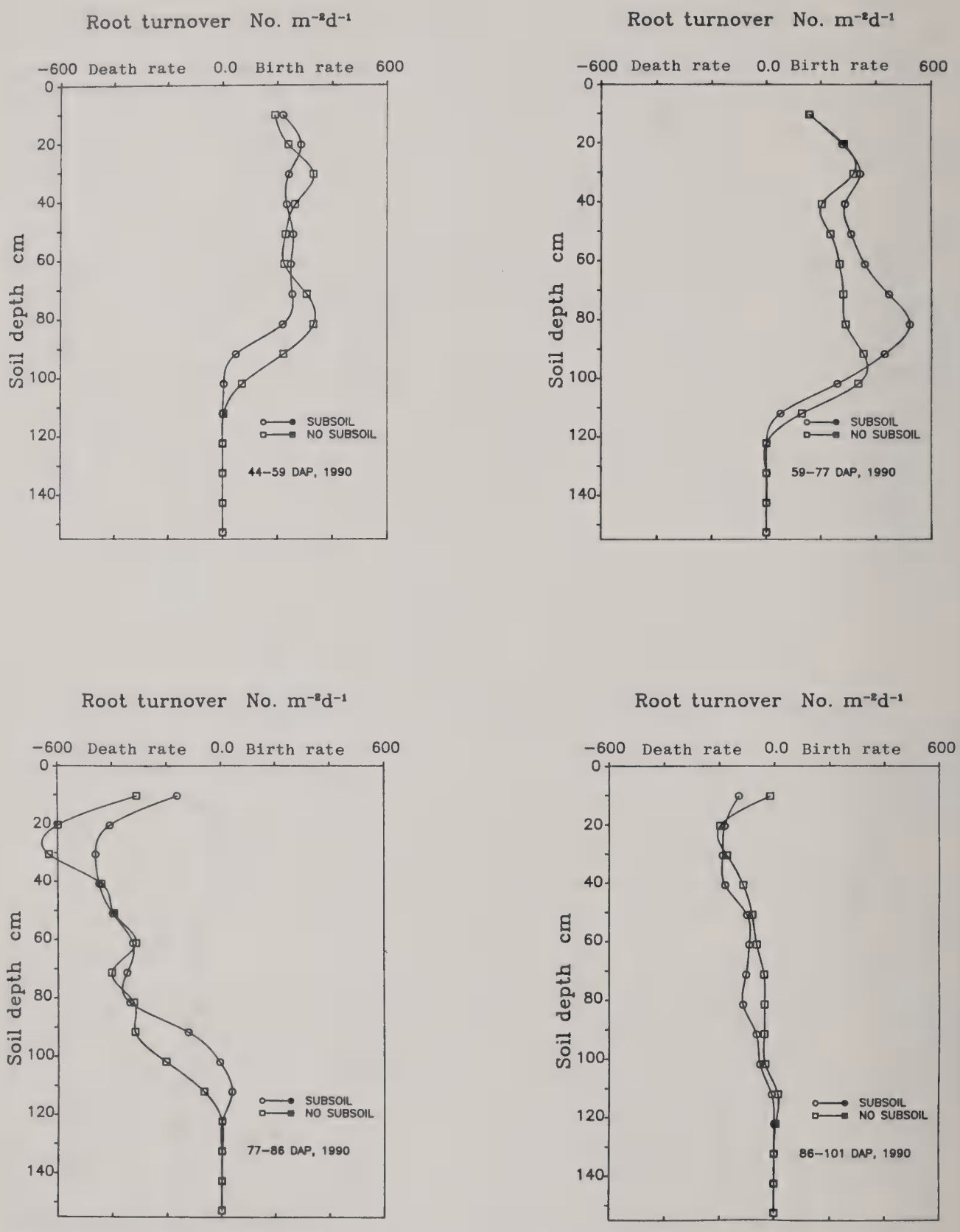

Fig. 3. Influence of subsoiling to 40 cm on the dynamic changes in the root numbers of two sugarbeet varieties, SR and E-4, within the soil profile of a Parkhill loam, Dorr Farm, 1990

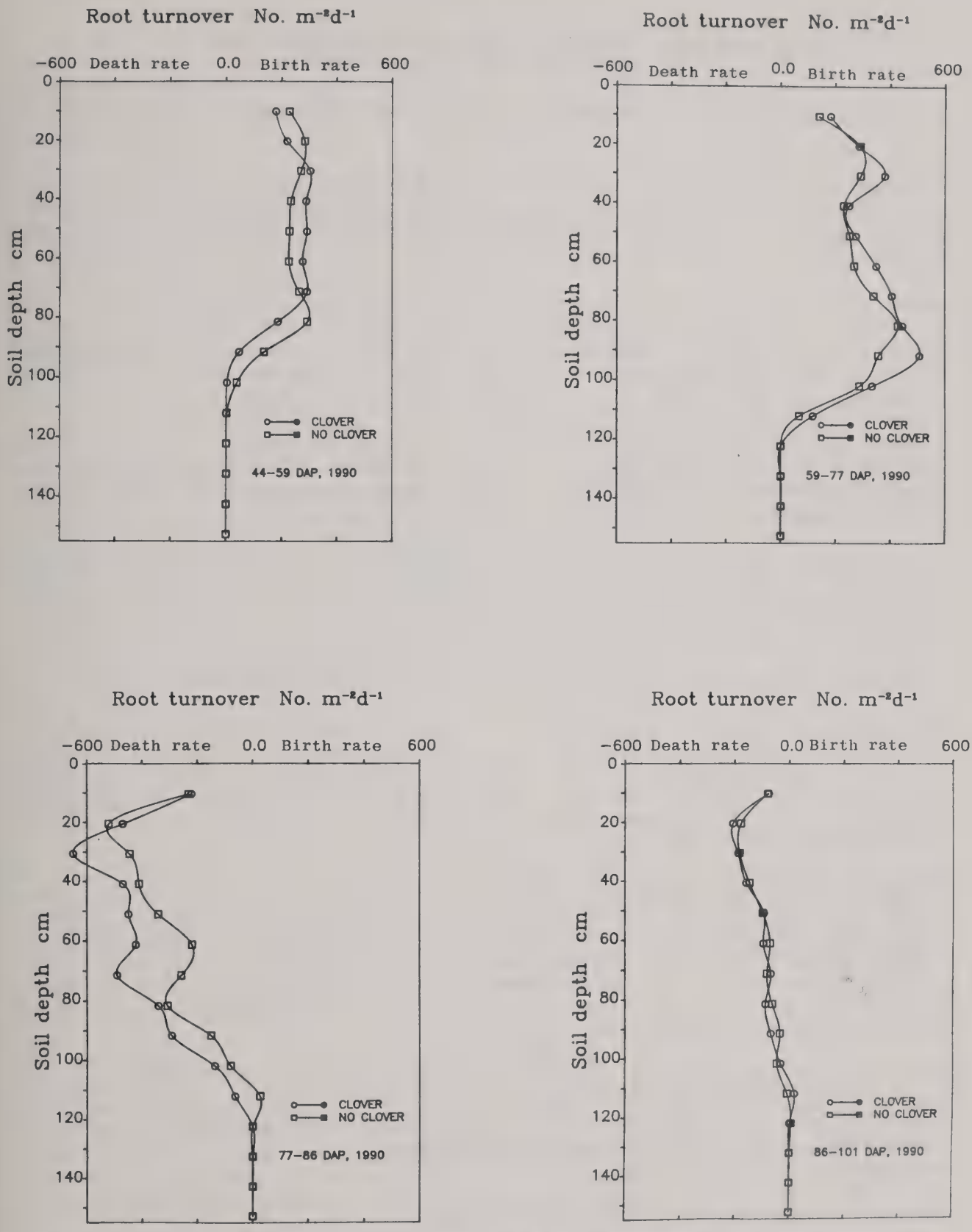

Fig. 4. Influence of previous clover crop on the dynamic changes in the root numbers of two sugarbeet varieties, SR and E-4, within the soil profile of ■ Parkhill loam, Dorr Farm, 1990

PHYSIOLOGY OF SULFONYLUREA HERBICIDE RESISTANCE OBTAINED FROM SOMATIC CELL SELECTION

J W. Saunders, S. E. Hart and D. Penner

Although selected on chlorsulfuron (the active ingredient in Dupont's Glean), the herbicide resistance we now have at the progeny whole plant level is also active against the related compounds primisulfuron (CIBA-Geigy's Beacon) and thifensulfuron (Dupont's Pinnacle).

Using resistant S_1 plants of heterozygous resistant isolate clone CR1-B and S_1 plants of susceptible source clone REL-1, and ^{14}C-primisulfuron applied to foliage, it was determined that both resistant and susceptible plants absorbed the herbicide at the same rate. There was also no difference in metabolism rates, with 10 - 12% metabolized within 72 hours.

In the absence of the herbicide, both resistant and susceptible plants had comparable activity levels of acetolactate synthase (ALS), the target enzyme for the sulfonylurea herbicides. However, differences between resistant and susceptible plants were found in sensitivity of ALS activity to inhibition by each of the three sulfonylurea compounds. Plant resistance to the herbicides was associated with enzyme activity resistance to inhibition in vitro by the herbicide in the enzyme reaction mixture. The exact magnitude of ALS activity resistance varied with the herbicide, being 15, 27, and 70 fold for primisulfuron, thifensulfuron, and chlorsulfuron, respectively. (Earlier tests had found a 300-1000 fold difference in sensitivity of in vitro shoots to chlorsulfuron to be associated with a single allelic difference.)

This mechanism of sulfonylurea resistance is the most common one being found currently in both weeds and crop plants. We can thus summarize our findings to date as indicating that our source of sulfonylurea resistance is inherited as a single dominant allele that conditions an altered ALS enzyme. We have chosen the allelic designations Sur and sur to indicate the resistance and susceptibility (wild type) alleles, respectively.

Based on preliminary results, the dominance is incomplete. S_1 plants from CR1-B were sorted out based on visual scoring of primisulfuron damage. Surviving (resistant) plants were later identified as homozygous or heterozygous based on S_1 or test cross progeny susceptibility to primisulfuron. Ten of 12 S_1 plants picked as homozygous were in fact identified as such, and 8 of 9 S_1 plants picked visually as likely heterozygotes were indeed identified as such.

The first homozygous line for this sulfonylurea herbicide resistance was released in 1990 as CR1-H. This is S_2 seed that quite probably contains detrimental somaclonal variation not associated with the herbicide resistance. Vigor is low. When concentration series of both primisulfuron and chlorsulfuron were tested on CR1-H and S_1 seed of the wild type source clone REL-1 using a pre-emergence application, it was found that CR1-H was 300-1000 fold less sensitive to each sulfonylurea compound.

Identifying and Manipulating the Enzymes and Genes for Betaine Synthesis in Sugarbeet.

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Project number: 730

Introduction:

The accumulation of glycine betaine in sugarbeets decreases the recovery of sugar from the expressed juice. Previous biochemical studies funded in part by the BSDF have helped to elucidate the biosynthetic pathway of glycine betaine in chenopods. We have now cloned the gene for the second enzyme in the pathway, betaine aldehyde dehydrogenase (BADH) from sugar beet using a heterologous clone obtained from spinach. This clone provides us with genetic information required to manipulate the biosynthetic pathway in an attempt to reduce betaine accumulation. By introducing various portions of the BADH gene back into sugarbeet in a reverse or "antisense" orientation, we will attempt to prevent the translation of active BADH enzyme and thus reduce or eliminate betaine biosynthesis. If successful, this technique could eventually produce material suitable for introduction into sugarbeet breeding stock.

Literature Review:

The biosynthetic pathway of glycine betaine in chenopods such as sugarbeet is now well established (1,2). The gene for BADH has been cloned from spinach (3), and used to obtain a clone for BADH from sugarbeet (McCue and Hanson submitted for publication). Sugarbeet has been shown to be transformable using the *Agrobacterium rhizogenes* system, and the transformed tissue has been regenerated into plants (4). Finally, antisense constructs have been successfully used to inhibit biochemical pathways in transformed plants (5).

1. Brouquisse R *et al.* Plant Physiol. 90:322-329.
2. Weretilnyk EA and Hanson AD (1989) Arch. Biochem. Biophys. 271:56-63.
3. Weretilnyk EA and Hanson AD (1990) Proc. Natl. Acad. Sci. 87:2745-2749.
4. Tepfer D (1989) in Plant-Microbe Interactions, Kosuge T & Nester EW, eds. 3:294-342
5. van der Krol AR *et al.* (1988) Nature 333:866-869.

Progress Towards The Objectives:

The first objective was to construct plasmids containing different parts of the BADH gene from sugarbeet inserted in the correct orientation to produce the transformation vectors. We have now prepared vectors with the entire gene for BADH (derived from the cDNA encoding BADH isolated from sugar beet), as well as a vector containing the 5-prime half (750 bp), and one containing the 3-prime half (1000 bp) of the gene, all in the antisense orientation. These constructs have been generated in the intermediate host *E. coli* for verification of insert orientation and plasmid integrity based upon digestion of plasmid DNA isolated from the transformed bacteria. The first vector, containing the entire gene, has already been transferred to *Agrobacterium rhizogenes* using the direct transformation method, and presence of the plasmid with insert has been verified. The second vector containing the 5-prime half of the gene has been transferred to *A. rhizogenes* and is in the process of being verified. The third vector is ready for introduction into the intermediate host.

Future Goals:

The next step will be to use *A. rhizogenes* to inoculate surface sterilized petiole explants from sugar beet leaves. We will use *A. rhizogenes* isolates containing the vector alone (without the BADH insert), and the three constructs containing the various portions of the BADH gene in the antisense orientation. Successful infection of sugarbeet by the *A. rhizogenes* will result in fast growing "hairy roots". These roots will then be sub-cultured, cured of bacteria and analyzed for altered levels of BADH activity. Constructs which result in reduced BADH activity will be used for the regeneration of plants to examine the effect of reduced betaine levels at the whole plant level. The long term goals of this project will be to back-cross transformed plants which exhibit reduced betaine levels to produce plants suitable for introduction into breeding programs.

SUGARBEET RESEARCH

1990 Report

Section F

University of Idaho
Idaho

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CONTENTS

Non-Chemical Means to Reduce the Sugarbeet Cyst Nematode Population and Minimizing Yield Losses

Saad L. Hafez

In Idaho and eastern Oregon the sugarbeet cyst nematode has been recognized as one of the most serious problems for the sugarbeet industry. It is, in fact, one of the most important limiting factors for sugarbeet production. Growers must choose between a long rotation practice using non-host plant or applying expensive nematicides to obtain optimum yield in nematode infested fields. In Idaho and eastern Oregon more than 50% of the sugarbeet acreage is infested with sugarbeet cyst nematodes at a level where treatment is a must to obtain economically feasible yield.

The damage caused by this nematode depends on the initial nematode population density, and on the general soil and climate conditions which influence the growth of the host plant and the nematode survival. In areas of intensive sugarbeet production and short rotations, it is impossible to grow a profitable crop without expensive nematicide application.

Because of the strict EPA regulations on existing nematicides and the new ones, and the increasing cost of chemical control, there is a need for developing an alternative control tactic for sugarbeet nematodes.

Some of the alternative cultural and biological tactics under investigation are:

1. The use of green manure crop as soil amendment (e.g. nematode resistant oil radish variety.

2. The use of nematode resistant oil radish varieties in sugarbeet rotation as a trap crop to control the sugarbeet cyst nematode.

3. The use of rapeseed oil meal. Meal extracted for high glucosonulate variety contained chemicals similar to the active ingredient of the nematicide vapam.

Accomplishments

1. The effect of different nematode resistant oil radish varieties on sugarbeet cyst nematode population.

   It is known that host root exudate stimulate hatching of the cyst nematode. If the eggs hatch and there is no susceptible host for larvae to feed on, they will die from starvation.

   Most of the radish family plants are considered hosts to the sugarbeet cyst nematode. Some of the radish varieties have been found resistant to thisnematode and can be used as a trap crop. Several varieties developed in Germany were found to stimulate cyst nematode hatching but does not provide all of the nutrients required for female development.

The result of the ongoing sugarbeet rotation research at Parma Idaho (Table 1,2,3) indicated that planting these nematode resistant oil radish varieties in the fall following wheat crop will reduce the cyst nematode population significantly in comparison to no-plant. Nematode larvae can develop into females or males depending on certain conditions during their development. There are indications that these oil radish varieties disrupt the normal development of larvae to become females, thus resulting in an unusually high number of males.

Table 1. The effect of nematode resistant oil radish varieties on sugarbeet cyst nematode population under field conditions.

a) Viable cyst /500 cc soil

Oil Radish Varieties	Sampling Date				% of Reduction
	Pre-Plant	Post-Plant			
	8/31/89	11/2/89	3/19/90	6/27/90	
1. Pagletta	7.0	6.0	4.0	3.0	57%
2. Nemex	9.0	9.0	11.0	4.0	55%
3. R-1 84	6.0	6.0	2.0	3.0	50%
4. No. Plant	12.0	11.0	9.0	9.0	25%

Crop History

Spring 1989 Wheat
Fall 1989 Oil Radish
Spring 1990 Dry Beans

Table 2. The effect of nematode resistant oil radish varieties on sugarbeet cyst nematode population under field conditions. ID 1990.

b) Total # of eggs & larvae /500 cc soil

Oil Radish Varieties	Sampling Date				% of Reduction
	Pre-Plant	Post-Plant			
	8/31/89	11/2/89	3/19/90	6/27/90	
1. Pagletta	581	750	328	237	59.2
2. Nemex	900	720	847	668	25.8
3. R-1 84	528	336	198	234	55.7
4. No. Plant	1260	840	821	809	35.8

Table 3. The effect of nematode resistant oil radish varieties on sugarbeet cyst nematode population under field conditions. ID 1990

c) Total # of eggs /500 cc soil

Oil Radish Varieties	Sampling Date				% of Reduction
	Pre-Plant	Post-Plant			
	8/31/89	11/2/89	3/19/90	6/27/90	
1. Pagletta	420	624	200	159	62
2. Nemex	594	558	572	568	4
3. R-1 84	408	222	134	159	61
4. No. Plant	984	720	668	603	39

2. The effect of rape seed oil meal on sugarbeet plant growth and cyst nematode population.

Rape seed meal, nitrogen, (Amonium sulfate), and Temik at the rate of 4,000, 200 and 33 lbs/A were applied in the spring in a sugarbeet field heavily infested with sugarbeet cyst nematodes. Each treatment was replicated five times in randomize strip design and an untreated control was included. Rape and nitrogen treatments were applied 2 weeks before planting, Temik was applied at planting. The nitrogen treatment was included to exclude the nutrient effect of the rape meal from its nematicide effect. Results for this trial indicated that rape seed

meal significantly increased the sugarbeet root yield under heavy infestation of sugarbeet cyst nematode. (Table 4)

Table 4. The effecte of Rape Seed oil meal on sugarbeet yield and cyst nematode population.

Treatment		Yield # of Beets IA	Yield T/A	Nematode Population Before Treatment #of Eggs/500cc soil
1	Rape Meal 2 T/A	16,125	26.2	1182.6
2	Nitrogen 200 lbs/A	15,938	23.9	583
3	Temik 15G 5 lbs ai/A	16,063	20.7	875
4	Untreated	14,375	16.0	1180

3. Sugarbeet resistant hybrids test:
Several sugarbeet hybrids were evaluated under greenhouse conditions to determine their susceptibility to sugarbeet cyst nematode by measuring nematode population build up. Results of this test indicated that most of the hybrids tested significantly reduced the nematode population. (Table 5) In comparison with the susceptible variety Mono Hy
RH 83.

Table 5. The effect of different sugarbeet nematode resistant hybrids on sugarbeet cyst nematode populations under greenhouse conditions.

Sugarbeet Hybrids	Cyst Nematode Population					
	Roots	Soil				
	Cyst/Plant	Mature Female	# of Eggs/ Cyst	# of Larvae/ Cyst	No. of E & L/ 1cc Soil	% of Reduction
1. KWS-1	34	235	205	23	107.2	50.1
2. KWS-2	10	291	136	24	93.1	57.1
3. KWS-3	14	103	153	30	37.7	82.6
4. KWS-4	13	235	132	19	71.0	67.3
5. KWS-5	11	291	116	26	82.6	61.9
6. N801-HLB Hyb.13883	9	103	103	17	24.7	88.6
7. M. HYRH83	22	542	166	34	216.8	--

Pot size 4" x 4" 500cc soil
Initial nematode population 13.5 egg/1cc soil
Planting date 8/25/89
Harvesting date 12/11/89

dw007

BIOLOGICAL CONTROL OF SUGAR BEET DISEASES Report for funding May 1990 - Feb. 1991

Anne J. Anderson, Biology, Utah State University and
John J. Gallian, Extension, University of Idaho.

Sugar beet seedling survival is influenced by physical and microbial factors. Reduced germination and seedling emergence is often the consequence of infections by plant pathogenic microbes. Current practice of fungicide treatment is not always satisfactory and overplanting is costly. Thus additional control measures are desirable to combat the pathogens. This research initiates the possible use of beneficial microbes that are antagonistic to the pathogens. This strategy of biocontrol is as effective as fungicide treatments in other systems.

We focussed on the isolation of bacteria that have the potential to antagonize two fungal pathogens *Phoma betae*, which is often introduced with the seed, and *Rhizoctonia solani*, which is soil borne. Both of these pathogens can reduce seedling stand.

We screened for potential antagonists of the fungi by examining bacteria which were present in sugar beet seeds and on field grown roots. These isolates should have the ability to colonize the plant and thus maintain populations effective against the pathogens. Our initial screen was to use an *in vitro* assay to detect the bacteria which displayed an ability to impair fungal growth. The bacteria which were most antagonistic were examined in greenhouse trials to study their effects on development of the Phoma- caused disease *in planta*. The most promising isolates were used in two preliminary field trials to develope suitable methods to examine efficacy of the bacterial treatments under normal growing conditions. We plan to perform additional field trials with selected isolates in the Spring of 1991.

METHODS

Isolation of bacteria from sugar beet.

Sugar beet seeds were surface sterilized using hypochlorite treatment. After washing the seeds were transferred on to bacterial growth media (King's B plates) and incubated at 22° C. Bacterial colonies originating from the seed were single colony isolated and stored at 6° C.

Bacteria were recovered from the surfaces of one month and two month old plants that were grown at the Experiment Station farm at Kimberly Idaho. Bacteria were also isolated from internal tissues of surface sterilized two month old plants.

Antagonism of *Phoma* and *Rhizoctonia*

Virulent isolates of the sugar beet pathogens *Phoma betae* and *Rhizoctonia solani* were obtained from J Gallian and were maintained on potato dextrose agar with frequent passage through the beet to ensure virulence. Plugs of inocula from these fungal pathogens were placed in the center of potato dextrose agar and King's B plates and drops of bacterial inocula were positioned 5 cm from the inocula. The effect of the bacteria on the growth of

fungi was visually recorded after 1 week of growth.

Greenhouse trials

Seeds were inoculated with *Phoma* by vacuum infiltration using 10^3 conidia/ml. The bacteria were inoculated onto these seeds or onto clean seed by vacuum infiltration using 10^9 cells/ml. Other seeds were not treated with bacteria to provide control data. Seeds were planted in sterilized vermiculite and grown at 26° C. Emergence and seedling health were rated over a 7 day time course.

Field trials

Seeds were inoculated as described and planted by the standard method of Gallian at the Kimberly farm in April and in May. Two rows each of 100 seeds were planted using four replications. Seedling emergence was recorded.

RESULTS

Bacteria were readily recoverable from the sugar beet seeds and roots. The bacteria were initially divided into three groups according to their pigmentation on agar plates (Table 1). Two of these Groups (group I and II) were fluorescent pseudomonads. The others, Group III, were white or yellow colored and it is likely that several genera are represented.

TABLE 1. Properties of bacteria isolated from sugar beet seeds and roots

	Group		
Isolate Source	I	II	III
Rhizosphere (40 one month old plants)			
Total	14	14	17
HCN producing	5	5	11
Strong *Phoma* Antagonism	5	14	3 of 4 tested
Strong *Rhizoctonia* antagonism	6	10	2 of 4 tested
Rhizoplane (3 month old roots)			
Total	4	0	8
HCN producing	2	0	2
Strong *Phoma* Antagonism	2 of 3	0	5 of 5 tested

TABLE 1. continued

Isolate Source	Group I	II	III
Strong *Rhizoctonia* antagonism	3	0	2 of 5 tested
Rhizoplane and Internal (6 two month old roots)			
Total	1	0	6
HCN producing	0	0	1
Strong *Phoma* Antagonism	1	0	0
Strong *Rhizoctonia* antagonism	1	0	1 of 2 tested
Internal (5 two month old roots)			
Total	0	0	5
HCN producing	0	0	0
Strong *Phoma* Antagonism	0	0	0
Strong *Rhizoctonia* antagonism	0	0	4 of 4 tested
Seed (30 seeds)			
Total	4	0	30
HCN producing	0	0	1
Strong *Phoma* Antagonism	0	0	6 of 21 tested
Strong *Rhizoctonia* antagonism	1	0	3 of 21 tested

Bacteria were isolated from seed or from the root surface or internal tissues of seedlings as described in Methods. The bacteria were classified by appearance on King's B medium into three groups; I and II are fluorescent pseudomonads, III are all other bacteria. Assays for the production of HCN, and *in vitro* antagonism of *Phoma* and *Rhizoctonia* followed methods described in Methods.

Antagonism of *Phoma* and *Rhizoctonia in vitro* was detected for many of the bacteria (Table 1). An exception was the yellow bacteria isolated from the sugar beet seeds which showed no inhibition of growth for either *Rhizoctonia* or *Phoma*. In general antagonism was apparent on both the iron deficient King' B medium as well as the iron rich potato dextrose agar. One subgroup of the fluorescent pseudomonads termed Group II developed intense brown or green pigmentation when grown in the presence of the pathogens (Table I).These bacteria were isolated only from the rhizosphere and were the most inhibitory group. Several of the Group II bacteria were identified as *P. tolaasii* isolates (Table 2). Some of the bacteria in each of the groups were able to produce HCN (Table 1), a factor which has been associated with pathogen suppression in other studies.

Certain of the bacteria which displayed strongest *in vitro* antagonistic potential were also able to suppress *Phoma* in greenhouse studies. The data are summarized in Table 2. Several Group 2 isolates were effective. Other isolates examined were one from Group I, a *P. aureofaciens* strain and two Group III isolates, a *Serratia* and a *Corynebacterium*. The bacteria appear to effect emergence and seedling health differentially. For example isolate R1-I-1 appeared to aid emergence but had a detrimental effect on seedling health.

TABLE 2. Effect of bacteria treatment on emergence and disease in seedlings from *Phoma*-infected seed.

Treatment		% Emergence	% Healthy seedlings
Phoma control		55 a	23 a
Group I			
R 1-I-1	P. aureofaciens	80 b	21 a
Group II			
P1E	P. tolaasii	56 a	83 b
P2E	P. tolaasii	66 a	73 b
P5A	P. tolaasii	57 a	87 b
P9A	P. tolaasii	70 b	52 a
P9D	P. tolaasii	66 a	81 b
Group III			
R3L-2	Serratia	50 a	76 b
J2B3	Corynebacterium	71 b	39 a

Bacteria were applied to sugar beet seeds prior to planting as described in Methods. Emergence and seedling health were determined after 7 days of incubation. Data are the means from 3 studies each of 50 seeds. Values followed by the same letter are not significantly different (10%) according to the Waller-Duncans test.

The data for two field trials are listed in Table 3. The presence of the bacteria had no effect on emergence in the seeds planted in April. In the May trial emergence of all

seeds was low but there was improved emergence associated with seed treatment with certain bacteria.

TABLE 3. Field trial data

Treatment	Emergence
April study	
Phoma	70
Phoma + R3L-2	76
Phoma + P5A	59
Phoma + J2B3	74
May study	
Phoma	14
Phoma + J2B3	17
Phoma + P5A	23
Phoma + R3L-2	21
Phoma + P9D	29

CONCLUSIONS.

Certain bacteria isolated from sugar beet seeds and roots of one and two month old field grown seedlings displayed the potential to antagonize two fungal pathogens associated with sugar beet roots. Antagonism was apparent in *in vitro* studies and in greenhouse trials. Several of the most effective isolates were identified as *P. tolaasii* according to their lipid compositions.

The *in vitro* studies suggest that the antagonism was independent of the presence of iron. This aspect was investigated because in other studies the mode of pathogen suppression has been correlated to the production of iron chelating siderophores by beneficial pseudomonads. These highly effective siderophores effectively starve the pathogen of iron and reduce its growth potential. We also failed to observe a consistent correlation between suppression and the production of HCN although this trait has been associated with biocontrol in other systems. The production of pigmentation by the group of bacteria which display strong antagonism resembles the observations with an isolate of *P. fluorescens* 2-79 which is an effective antagonist of the fungus which causes take all decline in wheat. Because antagonism by 2-79 is associated with antibiotic production, these data suggest that

antibiotics may be important in restricting growth of *Phoma* and *Rhizoctonia*. Certain of the isolates displaying *in vitro* antagonism were also effective at suppressing the development of symptoms associated with *Phoma* in greenhouse trials. The isolates selected had differential effects on seedling emergence and on protecting seedling health. These data suggest that distinct events involving different mechanisms may be occurring at various stages in protection.

The preliminary field trials allowed the development of procedures which will be used in more extensive studies in 1991. The data obtained illustrate variability in the protection observed but the beneficial effects seen in the May trial are encouraging.

FUTURE STUDIES.

We propose to continue greenhouse screening to examine the efficacy of the bacterial isolates against *Rhizoctonia*. We would hope to select isolates which are effective against both pathogens. A wider screen for efficacy would involve looking at the suppression of growth of other seed borne pathogens, *Alternaria* and *Fusarium*, detected in the Oregon grown seed. We anticipate screening *in vitro* as an initial step.

Understanding the mechanisms of suppression offered by the bacteria will be attempted initially by mutational analysis. For example, deletion of the ability of the pigmented class of pseudomonads to produce the pigment will be attempted.If pigment formation is associated with impaired fungal growth, these mutants should be reduced in their ability to suppress the pathogen.We would also learn whether the same pigment is inhibitory to one or more of the pathogens.If an antibiotic is the active agent then the antagonism may be effective in a greater variety of field soils than if iron limitation is the determinant trait.

Combinations of bacteria will be used to determine whether there are synergistic effects. For example one bacteria may be more effective at improving germination whereas another may be better at promoting seedling health.

Greater numbers of field trials will be performed to investigate correlation between protection in greenhouse and field conditions for this sugar beet biocontrol system.

SUGARBEET RESEARCH

1990 Report

Section G

Texas Agricultural Experiment Station
Bushland, Texas

Dr. C. M. Rush

Cooperation:

Imperial Holly - Hereford, Texas

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CONTENTS

PUBLICATIONS

Abstracts of Papers Published or Approved for Publication.

Martyn, R. D., D. H. Kim, C. M. Rush, and E. A. Dillard. 1990. Relationship among the vascular wilt fusaria of the Chenopodiaceae. Phytopathology 80:1008.

Isolates of *Fusarium oxysporum* causing vascular wilt in the Chenopodiaceae plants sugar beet (*Beta vulgaris*), spinach (*Spinacia oleracea*), and redroot pigweed (*Amaranthus retroflexus*) were compared using host pathogenicity, isozyme relatedness, and mtDNA RFLP patterns. Pathogenicity tests indicated a range of host specificity among the isolates, i.e. some were specific to their original host, a few primarily were pathogenic to their original host but caused some wilt on other hosts, and two isolates were highly pathogenic to both sugar beet and spinach and moderately pathogenic to pigweed. Isozyme profiles and mtDNA hybridizations correlated with the pathogenicity results. Isolates specific to sugar beet had similar isozyme matching distances, but were distant from isolates specific to spinach, while a cross-over isolate had a matching distance in between. RFLP analysis revealed three main polymorphic groups and two subgroups: isolates specific to sugar beet and spinach separated into two distinct groups while two cross-over isolates were in a third group. These data suggest that while most isolates display a high degree of host specificity, there exists within the population isolates that cross-over to other species within the Chenopodiaceae.

Martyn, R. D., E. A. Dillard, and C. M. Rush. 1990. Host specific and nonhost specific isolates of *Fusarium oxysporum* recovered from sugar beet. J. of Sugar Beet Research (in press).

Sugar beet (*Beta vulgaris* L.) and spinach (*Spinacia oleracea* L.) are members of the Chenopodiaceae plant family. Red-root pigweed (*Amaranthus retroflexus*) is a cosmopolitan weed pest and in the Amaranthaceae family. A wilt disease caused by formae speciales of *Fusarium oxysporum* has been described on each of these plants. In this study, 20 isolates of *F. oxysporum* recovered from diseased plants were cross-inoculated onto each of the three species using three different inoculation procedures in an attempt to determine host-specificity of the isolates. Analysis of the inoculation tests defined several levels of host-specificity and aggressiveness among the 20 isolates; however, the inoculation method had little effect ont he results. Isolates specific to sugar beet and to spinach were identified as well as isolates that were pathogenic to both hosts. In addition, pigweed isolates were highly aggressive to sugar beet, but not to spinach. Of the three plant species tested, pigweed is the most tolerant to fusarium wilt. That there are isolates of *F. oxysporum* pathogenic to more than one plant species suggests that there is a continuum of pathogenicity within a given forma specialis.

Martyn, R. D., D.H. Kim, E. A. Dillard, and C. M. Rush. 1990. Isozyme relatedness and mtDNA RFLP groups of *Fusarium oxysporum* from sugar beet, spinach, and red-root pigweed. J. of Sugar Beet Research (in press).

Twenty isolates of *F. oxysporum* recovered from diseased sugar beet, spinach, and red-root pigweed plants were examined using isozyme profiles and mtDNA RFLP patterns to determine their relatedness. Five enzymes (G-6-PD, MDH, CAD, PGI, and ADH) were electrophoresed using polyacrylamide gels. Isozyme bands were scored as binomial data and subjected to a cluster analysis program to generate matching distances between isolates. When analyzed individually, each enzyme separated the isolates into three main groups that correlated with host specificity. When all five enzymes were analyzed together each main group separated into sub-groups that correlated to aggressiveness of the isolates. Genomic DNA from each isolate was probed with a mtDNA PstI polyprobe (pFON1-pFON9) constructed from *F. o.* f. sp. *niveum* and examined for polymorphisms. Six RFLP groups were identified. Group I contained the cross-over isolates, group III contained host-specific spinach isolates. The remaining three groups separated out on the basis of reduced pathogenicity.

Mathieson, J. T. and C. M. Rush. 1990. Evaluation of fungicides for the control of powdery mildew on sugar beets, 1990. Fungicide and Nematicide Trials.

The experiment was conducted at The Texas Agricultural Experiment Station research center near Bushland, Texas where powdery mildew has been a problem in the past. The soil was Pullman silty clay loam (39.2, 31.6, 29.2% sand-silt-clay, pH 6.3 and O.M. 1.58%). Beets were planted on 4 April 90 and cultivated on 7 May 90 for weeds. Fungicides were applied twice to the foliar portion of the plants. The fungicides were applied on 19 July 90 and again on 21 Aug 90 using fan tip sprayers at 30 PSI and 5 mph. Treatments were arranged in a randomized complete block with 4 replications. Disease evaluations were made on 21 Aug 90, 2 Sept 90, and 25 Sept 90. The foliage was rated with a scale of 0-5. Three ratings were made within each plot and then averaged. To obtain yield data the center 2 rows each 8'8" long were harvested by hand. Root yield, tons sugar per acre, and % sugar were then determined.

All fungicides tested with the exception of Supertin had a lower disease index on each of the three dates beets were evaluated. All treatments showed an increase in root yield, sugar per acre, and % sugar although the differences were not all significantly different when compared to the untreated check. Microthiol however was significantly better than the untreated check with regard to root yield and total sugar produced. Sugar beets treated with the combination of Bayleton 50WP + Penncozeb and Microthiol + SuperTin had significantly higher sugars than the untreated check.

Rush, C. M. 1990. An evaluation of seed priming techniques with five sugar beet cultivars. Phytopathology 80:971.

A greenhouse study was conducted in which the effects of priming technique on sugar beet seedling emergence and survival in *Pythium, Aphanomyces*, or non-infested soil were compared. NaCl and PEG 8000 solutions were compared to a solid matrix priming technique, SMP. Washed and non-treated seed were included as controls, and five cultivars were tested. In all soils and cultivars, SMP treated seed had significantly greater emergence after three days than all other treatments. After 15 days, stands of SMP treated seed were higher in *Pythium* infested soil but not in control or *Aphanomyces* infested soil. All priming

techniques resulted in significantly better emergence after 3 days than non-treated seed. Seed primed with PEG often performed no better than washed seed. Primed seed resulted in increased final stands and decreased pre-emergence damping off in *Pythium* infested soil. No treatment reduced seedling disease in *Aphanomyces* infested soil. SMP is a superior method of seed priming and the effects of priming are not cultivar specific.

Rush, C. M. 1991. Comparison of seed priming techniques with regard to seedling emergence and Pythium damping-off in sugar beet. Phytopathology (in press).

Three seed-priming techniques were compared for their effects on earliness, rate, and uniformity of seedling emergence of sugar beet in infested and uninfested soils. Seed was osmoprimed with -1.5 MPa NaCl or -1.2 MPa PEG 8000, or solid-matrix primed (SMP) with water and a hydrous-silicate clay as the solid substrate. Washed and untreated seed were included as controls. Seed was planted in soil infested with *Pythium ultimum* or in uninfested soil, and stand data were recorded for approximately 15 days. Three days after planting in uninfested soil, SMP- and NaCl-treated seed produced greater stands than the untreated control, and SMP-treated seed produced a greater stand and faster, more uniform emergence than all other treatments. Eight days after emergence, only the stand of the washed treatment was greater than the untreated control. Stands in all other treatments emerged at a faster rate than in the untreated control, and SMP induced faster emergence than any other treatment. In infested soil, primed seed also gave significantly better stands than washed or untreated seed 8 and 15 days after planting. Primed seed also had less preemergence damping-off, but there was no difference in post-emergence damping-off. SMP was better than both osmoprimed treatments in promoting early emergence, suppressing preemergence damping-off, and in producing a greater final stand. SMP-treated seed still maintained a "primed condition" 7 mo after treatment.

Rush, C. M., K. M. Vaughn, and J. E. Warner. 1991. Reduction in Aphanomyces seedling disease of sugar beet by management of soil moisture. J. Sugar Beet Research (in press).

Aphanomyces is the most common seedling pathogen of sugar beets grown in the Texas Panhandle. Since the infective unit of this pathogen is the zoospore, we hypothesized that disease control could be achieved by planting seed into a soil wet enough for seed germination but too dry for zoospore movement. In a laboratory study, sugar beet seed, cv. Tx-9, were untreated, solid matrix primed (SMP) or SMP and mixed with a fluid for fluid seeding. Seed were then planted into soils with matric water potentials adjusted to -1 through -9 bars, all of which are too dry for zoospore movement. Neither seed treatment nor soil matrix potential affected overall seed germination, but SMP treated seed and SMP+fluid both germinated faster and had better radicle growth at all matric potentials than the control. Seed with the same treatments were also planted in the greenhouse in boxes containing soil artificially infested with oospores of *Aphanomyces cochlioides*. Ten boxes were pre-irrigated and allowed to dry down to approximately -1.5 bar before planting. After planting, five of the boxes received a second irrigation. Seed treated with SMP or SMP+fluid emerged faster than non-treated seed in all boxes, but after six days no significant differences existed. After six days, seedling emergence in boxes irrigated post-plant was only slightly better than in pre-irrigated boxes, 100 vs. 97% respectively, but the

difference was significant. However, the average disease in boxes irrigated post-plant was 56% and only 5% in pre-irrigated boxes.

Rush, C. M. and S. R. Winter. 1990. Aphanomyces root rot of sugar beet as affected by wheat residue management, 1989. Biological and Cultural Tests for Control of Plant Diseases.

A 2 X 3 X 3 sub-sub plot experimental design consisting of grazed or ungrazed main plots; conventional till, burned, or reduced till sub plots; and 0, 89, or 178 kg N/ha (NH_3) sub-sub plots with three replications was established. Hard red winter wheat (*Triticum aestivum* L.) was grazed in the spring of 1988 for three weeks. Main plots were 45 X 18 m. Following wheat harvest in June 1988, 15 X 18 m tillage sub plots were implemented. Conventional tillage plots were disked twice and chiseled once to a depth of 25 cm. Wide beds (1.5 m) were formed and run over with a rolling cultivator once to break up clods. The burned treatment was identical to the conventional except wheat residue was burned before disking. Reduced till plots were untouched until a week before planting. It was determined that the excessive amount of surface residue would interfere with planting and stand establishment, so plots were rototilled to incorporate the residue in the surface 15 cm. Preplant applications of Nortron (3.4 kg ai/ha) and Phorate 1.1 kg ai/ha) were incorporated into the soil for weed and insect control, respectively. Beets (76 cm row spacing, 2 rows/bed) were planted 31 March and irrigated for emergence. On 19 June, NH_3 treatments were incorporated into the test by side dressing eight rows in each sub plot with nitrogen at rates of 0, 89, or 178 kg/ha resulting in 15 X 6 m sub-sub plots. Disease incidence was determined by counting diseased beets in two 15 m rows of each sub-sub plots. Diseased beets were pulled to verify the presence of Aphanomyces root rot and then discarded. Four 15 m rows in each sub-sub plot were harvested with a commercial beet digger for yield and sub-samples were taken for sucrose determinations. Data was subjected to ANOVA and Duncan's test (P=-.05) was used for mean separation. Regression analysis was used to evaluate nitrogen effects.

Disease development during the season was adequate for analysis of treatment effects. Grazing had no significant effect on any of the measured parameters and there was no interaction of grazing*tillage, grazing*N, or grazing*tillage*N. Regression analysis showed that N significantly affected percent sucrose, r^2=.10. Nitrogen had no effect on percent disease. The nitrogen treatments may have been implemented too late to affect disease development. It is unknown whether the significant increase in disease incidence in the reduced till treatment was associated with high level of residue, physical changes in soil structure due to tillage, or some other factor or combination of factors.

Rush, C. M. and S. R. Winter. 1990. Influence of previous crop on Rhizoctonia root rot and crown rot of sugar beet. Plant Disease 74:421-425.

A field study was conducted to determine the effects of previous crops on Rhizoctonia root and crown rot development in the subsequent sugar beet crop. Alfalfa, cotton, sorghum, sunflower, or wheat, grown in monoculture for 2-3 yr, or fallow ground, preceded sugar beets grown in 1987 and 1988. Disease incidence in the sugar beet crop was monitored by bimonthly counts of dead plants in two 7.6-m lengths of row in each plot. At the end of the

season in 1987, sugar beets following alfalfa had the highest incidence of disease, losing 47% of the stand to root rot. Sugar beets on sorghum and winter wheat ground followed with 41 and 38% stand losses, respectively. Sugar beets preceded by cotton, fallow, and sunflower all had significantly less disease, with 32, 22, and 21% losses, respectively. In 1988, results were similar. By season's end, sugar beets preceded by wheat, sorghum, or alfalfa had 84, 81, or 48% stand losses, respectively. Cotton, fallow, and sunflower were again best for preceding sugar beets, with 30, 22, and 19% stand losses, respectively. Root yield was negatively correlated (P = 0.05) with percent disease, r = -0.96 in 1987 and r = -0.97 in 1988. In both years, sugar beets grown on previously fallow ground had significantly greater root yields than all other treatments except sunflower. Root yields of sugar beets following winter wheat and sorghum were low. However, in both years percent sucrose was highest in sugar beets following wheat. No significant differences were found when sugar beets followed the other crops either year. Previous crops also affected residual soil NO_3-N. In general, residual soil NO_3-N was lower in alfalfa, sorghum, and winter wheat plots than in cotton, fallow, or sunflower plots, but differences were not always significant. Although previous crops affected yield and root disease development in the subsequent sugar beet crop, many interacting variables, such as disease X yield, NO_3-N X yield, and NO_3-N X disease complicated interpretation of results.

EFFECTS OF SOIL, WATER POTENTIAL AND SEED TREATMENT ON GERMINATION AND DISEASE DEVELOPMENT IN SUGAR BEET

Charles M. Rush

Previous study revealed that primed sugar beet seed germinates and emerges faster than nonprimed seed. Seed priming also improves seedling emergence and survival in soils infested with *Pythium ultimum*, but not soils infested with *Aphanomyces cochlioides*. Traditionally, primed seed has shown the greatest advantage over nonprimed seed in cool, wet soils. However, we hypothesized that primed seed might also emerge better than nonprimed seed in relatively dry soils, and thereby be able to avoid infection by *A. cochlioides* which requires near saturated soils for zoospore movement. With this in mind, we initiated a laboratory study to determine how soil water potential affects seed germination and subsequent radicle growth, and to determine if Aphanomyces seedling disease could be managed by regulating irrigation at planting time. A second objective was to evaluate the efficacy of two biocontrol agents in controlling Aphanomyces seedling disease.

Methods

Soil water potential. The moisture release curve for a Pullman clay loam soil was determined to relate gravimetric soil water content to soil matric water potential (Fig. 1). Standard pressure plate methodology was used to establish specific matric potential-gravimetric water content equivalents. Next, soil samples were adjusted with pressure plates to soil matric potentials of -1, -3, -5, -7, and -9 bars. Soils were then stored in sealed plastic bags until use, usually no longer than 48 hours.

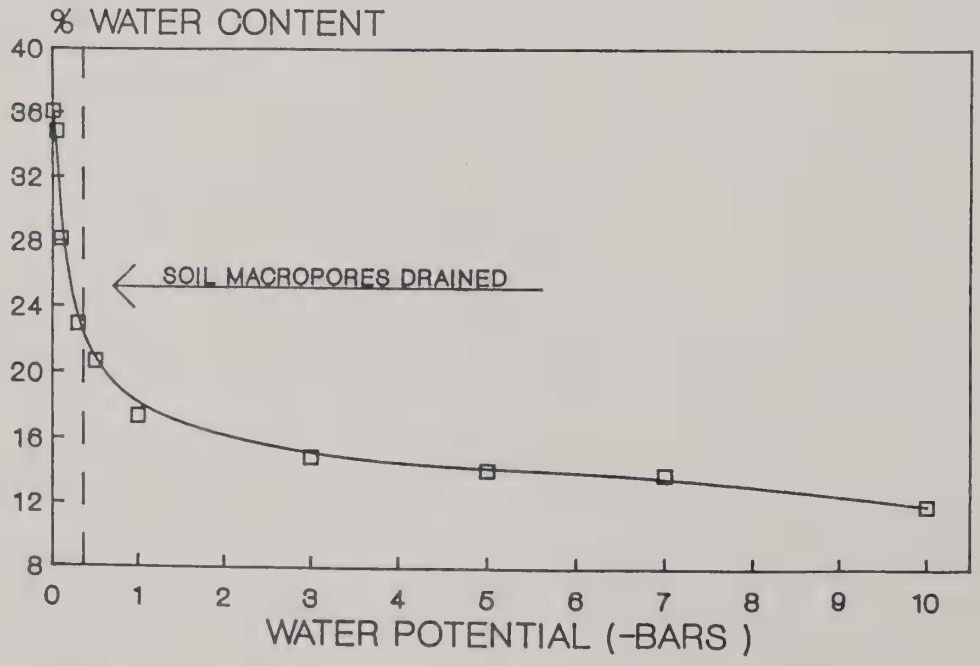

Fig. 1 Moisture release curve for Pullman clay loam soil

Physical seed treatments. Physical treatments included primed seed and primed plus N-Gel. Sugar beet seed were primed using the solid matrix technique: 22.7 g of sugar beet seed, Hilleshög Mono-hy cv Tx18, were mixed with 22.7 g of matrix and 22 ml H_2O. The mixture was placed in 10 cm diameter polystyrene tubes 15 cm long, and covered on both ends with plastic caps. These were placed on a roller (Gustafson Inc., Dallas, TX 75075) programmed to activate four times/day for 15 min., and incubated for two day at 15C. After the two day prime, the plastic caps were replaced with vented caps and the seed allowed to dry for three days. The primed seed were then separated from the solid matrix by sieving.

The product used for fluid seeding, N-Gel, is a dry powder, but when mixed with water becomes a viscous liquid. When mixed with seed it forms a thin film around the seed which allows the seed to be in a hydrated environment at planting.

Biological control agents. The bacterial and fungal biological control agents used in this study were obtained from Dr. Charlie Howell, USDA-ARS, National Cotton Laboratory, College Station, Tx., and had reported activity against oomycetes. *Enterobacter cloacae* was grown on nutrient agar and 24 hr after streaking the plates, 1 ml of bacteria was collected and used to treat 1000 seed. The fungal biocontrol agent, *Gleocladium virens* G9 was obtained in a powered form, and 1 g was used to treat 1000 seed. One ml of methylcellulose was first added to the seed as a sticker, and then the fungal inoculum was added and mixed thoroughly. Primed and nonprimed seed were treated with each biocontrol agent, and each biocontrol agent was also added to N-Gel and then mixed with primed seed.

Experiment design and disease evaluation. All studies except the one evaluating effects of water potential on seed germination, were conducted in the greenhouse in boxes filled with nonsterile soil. Oospore inoculum of Aphanomyces was added to each box and seed planted. There was a total of 10 boxes and all were irrigated preplant. After planting, half of the boxes were irrigated again. Stand counts were taken, and plants exhibiting symptoms of Aphanomyces seedling disease were counted and removed. These disease counts were continued for approximately four weeks.

Results and Discussion

Water Potential and Seed Germination. The effects of varying soil water potential on seed germination and radicle growth is illustrated in Fig. 2-5. Soil water potentials ranging from -1 to -9 bars had essentially no effect on seed germination (Fig. 2). Although percent germination began to drop off at -9 bars, seed still were able to germinate. Although all seed treatments were able to germinate at the lowest water potential, -9 bars, there was a great difference in overall percent germination, and primed seed + N-Gel > primed seed > untreated control. The same general trends were seen when evaluating the effects of water potential on radicle elongation and results are shown in Fig. 3. The radicle grew at all water potentials and there was a downward trend in the slope, but the biggest differences were between treatments. Again primed seed + N-Gel had the most growth.

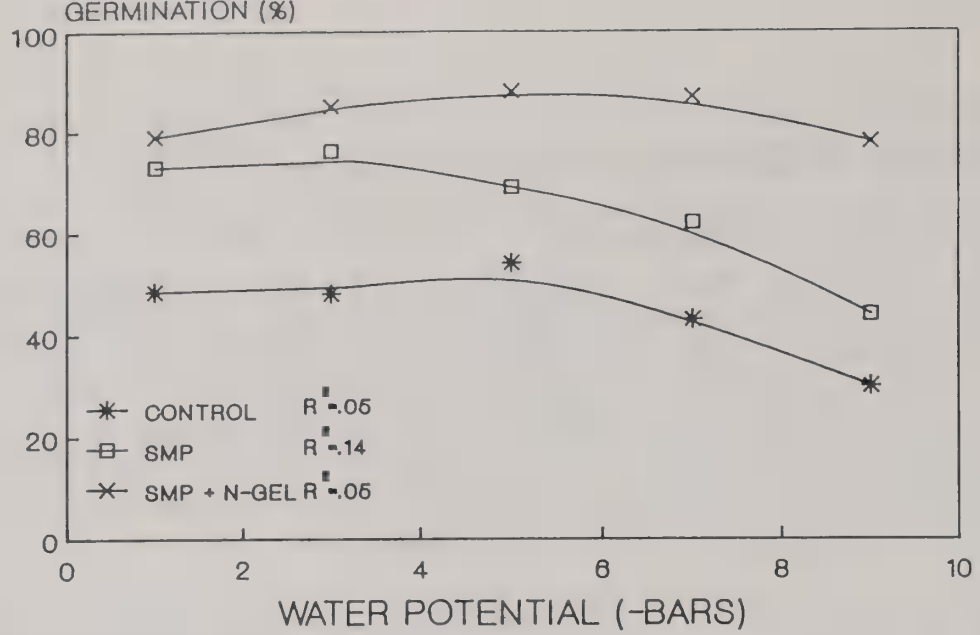

Fig. 2 Effects of seed treatment and water potential on germination

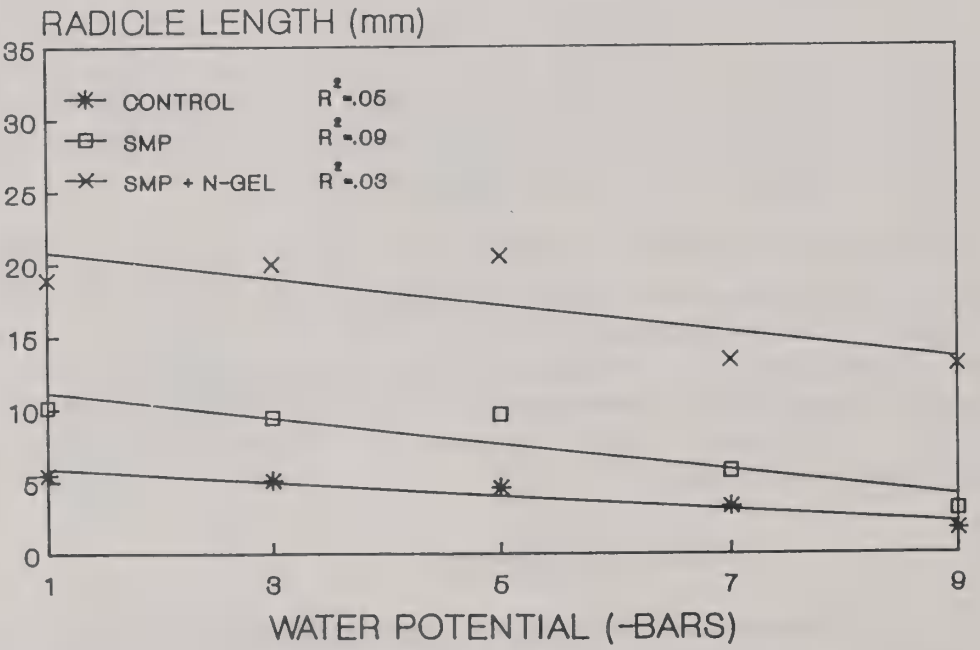

Fig. 3 Effects of seed treatment and water potential on radicle length

Although soil water potential had only a small effect on seed germination and radicle growth, these variables were greatly affected by time. As expected, germination increased over time, and there were great differences between seed treatments. The primed + N-Gel treated seed germinated much faster, and after only 48 hr, > 60% of the seed had germinated, while only 21% of the primed seed and none of the control had germinated (Fig. 4). Four days after planting, the primed + N-Gel and primed seed had reached maximum emergence, but the control did not reach maximum emergence until seven days after planting. Again, the same trends were seen with radicle elongation over time (Fig. 5). Seven days after planting, the mean radicle length from primed + N-Gel treated seed was > 35 mm while radicles from primed and control seed were 20 mm and 12 mm, respectively.

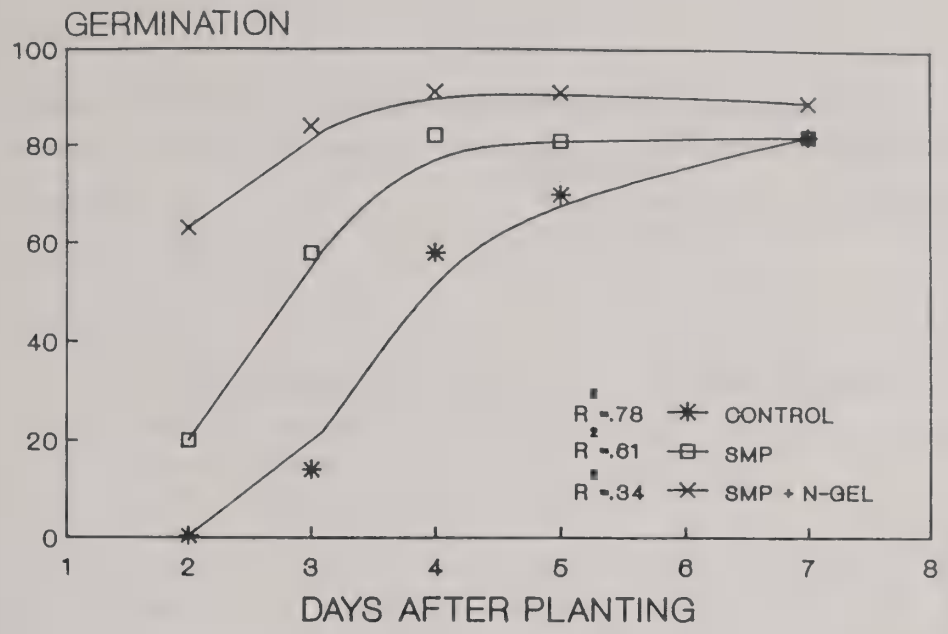

Fig. 4 Effect of seed treatment on sugar beet germination

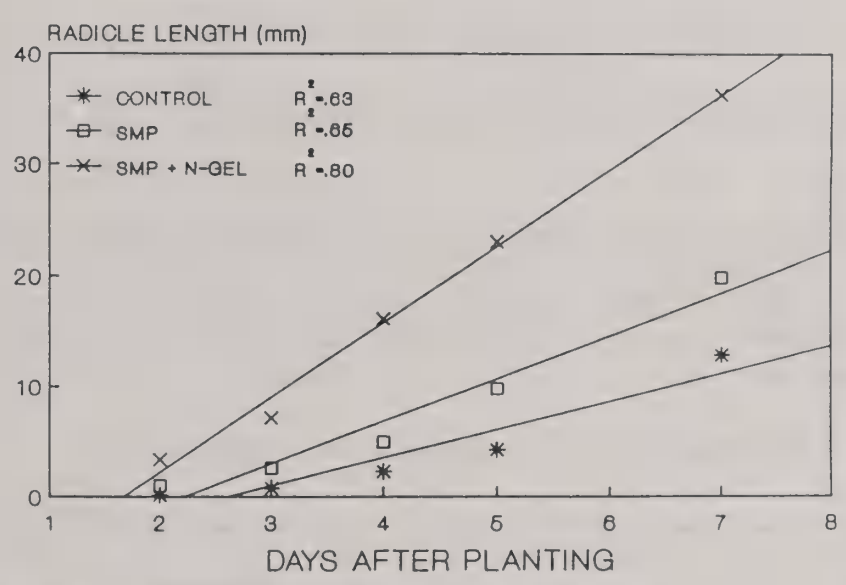

Fig. 5 Effects of seed treatment on radicle length over time

Seed germination and radicle growth over time is not merely an academic issue. A typical dry down curve for a Pullman clay loam is shown in Fig. 6. At 2.5 cm, a normal planting depth for sugar beets, the soil drys down very rapidly four days after irrigation. If seed was planted at this time, one could conclude from results presented in Fig. 4 that within four days after planting, all primed seed would have germinated. However, because untreated seed germinates slower, the water potential might be to dry for seed to germinate or for the radicle to grow. In Fig. 4, it took seven days to achieve maximum seed germination of untreated seed. Referring back to Fig. 6, if one planted four days after irrigating, the water potential in the top 2.5 cm was around -2 bars, but just five days later, nine days after irrigating, the soil water potential was near -15 bars, the permanent wilting point. At this water potential not all the untreated seed would have germinated, and it would have been too dry for radicle growth. The faster seed can germinate and initiate radicle growth, the better

its chance of survival, because even though the upper soil dries rapidly the deeper soil stays wet enough to support plant growth.

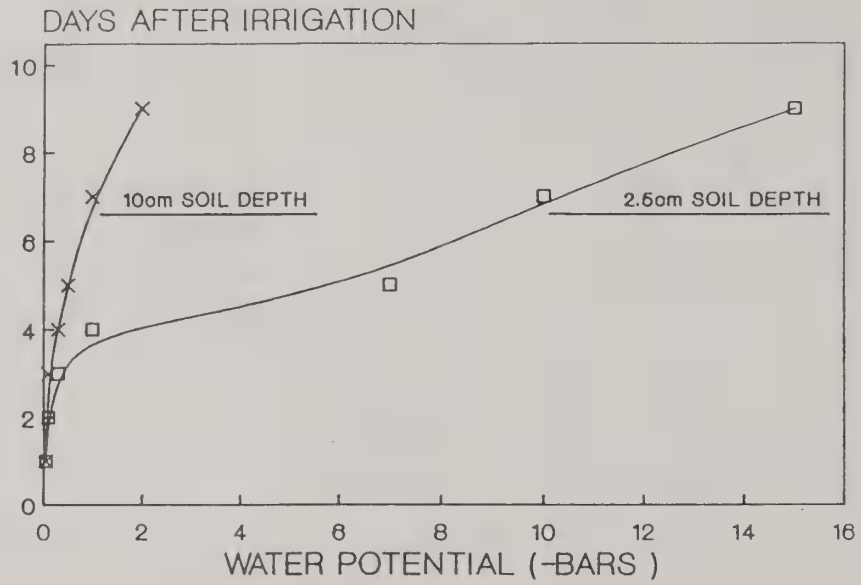

Fig. 6 Typical soil dry down curves for 2.5 cm and 10 cm depth

Physical seed treatments. The effects of irrigation and physical seed treatment on seedling emergence and disease are shown in Tables 1-2. Seed treatments had very little effect on either emergence or disease development, but irrigation had a great efffect on disease. In boxes which received only a pre-plant irrigation, Table 1, primed seed + N-Gel and primed seed alone had significantly greater stands three days after planting than untreated seed. However, neither emergence nor percent disease was affected by the seed treatments.

Table 1. Effects of seed treatment and irrigation on emergence and seedling disease.

Seed	Day 3		Day 6		% Disease[d]	
Treatment	Pre[a]	Post[b]	Pre	Post	Pre	Post
	- - - - - - - - - % Emergence[c] - - - - - - - - -					
SMP	61 b	92 a	98 a	100 a	4 a	63 a
SMP + N-Gel	77 a	94 a	100 a	100 a	8 a	63 a
Control	15 c	30 b	97 a	100 a	7 a	45 a
Control + Tachigarin	11 c	21 b	91 b	100 a	1 a	54 a

[a] These boxes received only pre-plant irrigation.
[b] These boxes were irrigated pre- and post-plant.
[c] Only disease incidence and not severity was evaluated. Any plant exhibiting typical Aphanoyces seedling disease symptoms was counted and then removed from the box.
[d] Means followed by the same letter are not significantly different according to Duncan's multiple range test (p=0.05). Each treatment had 50 seed per replication and was replicated five times.

Table 2. Irrigation effects on stand establishment and seedling disease[a].

Treatment	% Emergence Day 3	% Emergence Day 6	% Disease
Post-Irrigated	59 a[b]	100 a	56 a
Pre-Irrigated	41 b	97 b	5 b

[a] Irrigation effects inclusive of all seed treatments.
[b] Mean values followed by the same letter are not significantly different according to Duncan's multiple range test ($p=0.05$).

Likewise, in boxes which received a post-plant irrigation, there was a treatment difference in three day stands, but not in the six day emergence count or in the amount of disease (Table 1). When all seed treatments were merged and only the effects of irrigation were considered, there was a significantly better stand, three days after planting, in boxes which received a post-plant irrigation (Table 2). Although there was also a difference at day six, it was minimal. However, the effect of irrigation on disease development was not minimal. At the end of the study, 56 percent of the stand in post-plant irrigated boxes was diseased, while five percent was diseased in boxes receiving only a pre-plant irrigation. The small reduction in emergence in boxes which received only a pre-plant irrigation, was more than compensated for by the large reduction in disease.

Biological seed treatments. Biological seed treatments had minimal effect on emergence and disease (Table 3). The fungal biocontrol agent on nonprimed seed always had the lowest emergence, but differences were not always significant. None of the treatments significantly reduced disease incidence.

Table 3. Effect of seed treatment and irrigation on emergence and seedling disease.

Seed Treatment	Day 3 Pre[a]	Day 3 Post[b]	Day 6 Pre	Day 6 Post	% Disease[d] Pre	% Disease[d] Post
	- - - - - - - - - - - - % Emergence[c] - - - - - - - - - -					
SMP+N-Gel+Fungi	66 ab	97 a	96 ab	100 a	5 a	63 ab
SMP+N-Gel+Bacteria	62 ab	97 a	91 ab	100 a	4 a	70 a
SMP+N-Gel	77 a	94 a	100 a	100 a	8 a	63 ab
SMP	61 b	92 a	98 a	100 a	4 a	63 ab
SMP+Fungi	38 c	96 a	78 c	100 a	3 a	60 ab
SMP+Bacteria	52 bc	91 a	97 a	100 a	3 a	62 ab
Ck	15 d	30 b	97 a	100 a	6 a	45 b
Ck+Fungi	6 d	16 b	67 d	96 b	6 a	52 ab
Ck+Bacteria	9 d	26 b	87 b	100 a	6 a	57 ab

[a] These boxes received only pre-plant irrigation.
[b] These boxes were irrigated pre- and post-plant.
[c] Only disease incidence and not severity was evaluated. Any plant exhibiting typical Aphanoyces seedling disease symptoms was counted and then removed from the box.
[d] Means followed by the same letter are not significantly different according to Duncan's multiple range test ($p=0.05$). Each treatment had 50 seed per replication and was replicated five times.

SUGARBEET RESEARCH

1990 Report

Section H

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Geneva, New York

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Cooperation:

Cornell University
Geneva, New York

The research was supported in part by funds provided through the Cornell University and the Beet Sugar Development Foundation (Project 230).

CONTENTS

PROGRESS REPORT TO THE BEET SUGAR DEVELOPMENT FOUNDATION-1990-91

PROJECT TITLE: Matriconditioning of sugarbeet seeds to improve stand establishment

PROJECT LEADER: A. A. Khan, Professor of Seed Physiology

OTHER PERSONNEL: C. Roe and S. Ilyas

RESULTS:

Some of the highlights of research conductewd in 1990-91 are described here. Sugarbeet ('E-4, size medium, untreated) were used in all studies described here. Preliminary studies on seedling emergence was conducted in Cornell Peat-Lite Mix at 12h, 20°C day/10°C night temperature regime. The effects of seed coditioning and fungicide treatments were evaluated in the field at the Vegetable Research Farm of the NYSAES. Seeds were planted on June 1, 1990 in 5m rows, 75cm apart with 100 seeds/row at a depth of 2.5cm using a cone seeder. Treatments were replicated six times in a randomized complete block design. Emergence counts were made frequently with the final counts being made on June 20, 1990.

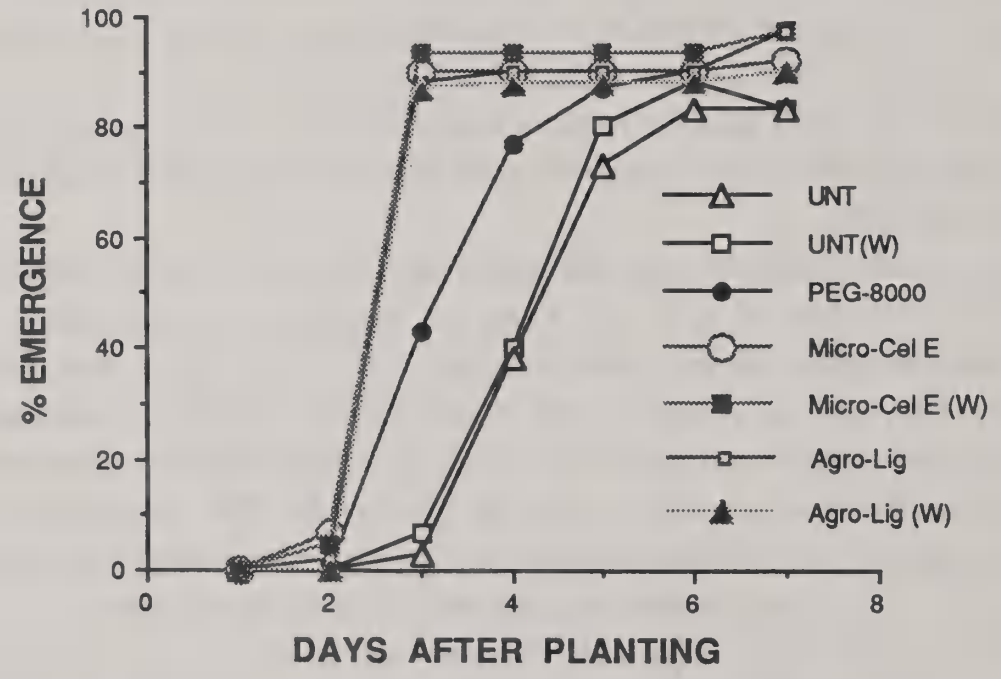
Seeds in small batches (4-16g) were treated with Apron 25W, Rizolex 50W, and Thiram 75W at the rate of 5, 20 and 41mg a.i., respectively. Combinations of Apron+Thiram and Apron+Thiram+Rizolex were also applied. Fungicides were applied to nonconditioned dry seeds as a slurry in 2.5ml of 1.5% Methocel. Fungicides were added directly to the conditioning matrix durng conditioning. Seeds were mixed with solid carrier and water in 0.47liter glass jars, loosely capped and transferred to 15°C for conditioning. The amounts and the combinations of fungicides applied during conditioning of sugarbeet seeds were identical to those applied to nonconditioned (dry) seeds used as controls. Water in the conditioning mixture was replaced by the same volumes of aqueous suspension of the fungicides used. Conditioned seeds were either dried by forced air for 2h without removal of the carrier adhering to seed surface (field studies) or conditioned seeds were planted without drying with or without removal of the carrier by washing (growth chamber studies in Peat-Lite).

Experiment: 1. *Effect of conditioning sugarbeet seeds with various solid carriers with or without washing on emergence at 10/20°C.*

Seeds were conditioned for 7 days with the following conditioning media : 1) 4g

seeds: 0.8g Micro-Cel E: 3.2 g water; 2) 4g Seeds: 6g Agro-Lig: 2.4g water; and 3) -1.2MPa PEG-8000. Seeds were conditioned with PEG solution in glass dishes at 15°C. After conditioning in PEG seeds were washed before planting in the Peat-Lite. It can be seen that both Micro-Cel E and Agro-Lig were effective carriers for reducing the time of emergence and improving the rate of emergence at the suboptimal temperature of 10/20°C (Fig.1). They were more effective than conditioning seeds in PEG. Washing (indicated by 'W' after carrier) of carriers had little effect on seed performance.

Fig.1



Experiment 2. *Effect of storage on emergence at 10/20°C of sugarbeet seeds preconditioned with solid and liquid carriers*

Seeds were conditioned with solid carriers Micro-Cel E, Agro-Lig and Expanded Vermiculite (#5) (4g seed: 1g Vermiculite: 2.5ml 0.2% Thiram) and PEG solution. In all cases 0.2% Thiram substitituted water during conditioning. After conditioning seeds were stored in open containers at 7°C and 30% RH for various times prior to determination of emergence at 10/20°C in the Peat-Lite. Up to 60 days of storage did not not adversely

affect the advantages gained by conditioning in various media (Figs. 2 and 3). Only a small reduction in the beginning of emergence, 3 day after planting (3DAP), occurred in Micro-Cel E coditioned seeds after storage. No significant differences were fouind among the conditioned seeds at 5 days (5DAP) and 13 days after planting (13DAP).

Fig. 2

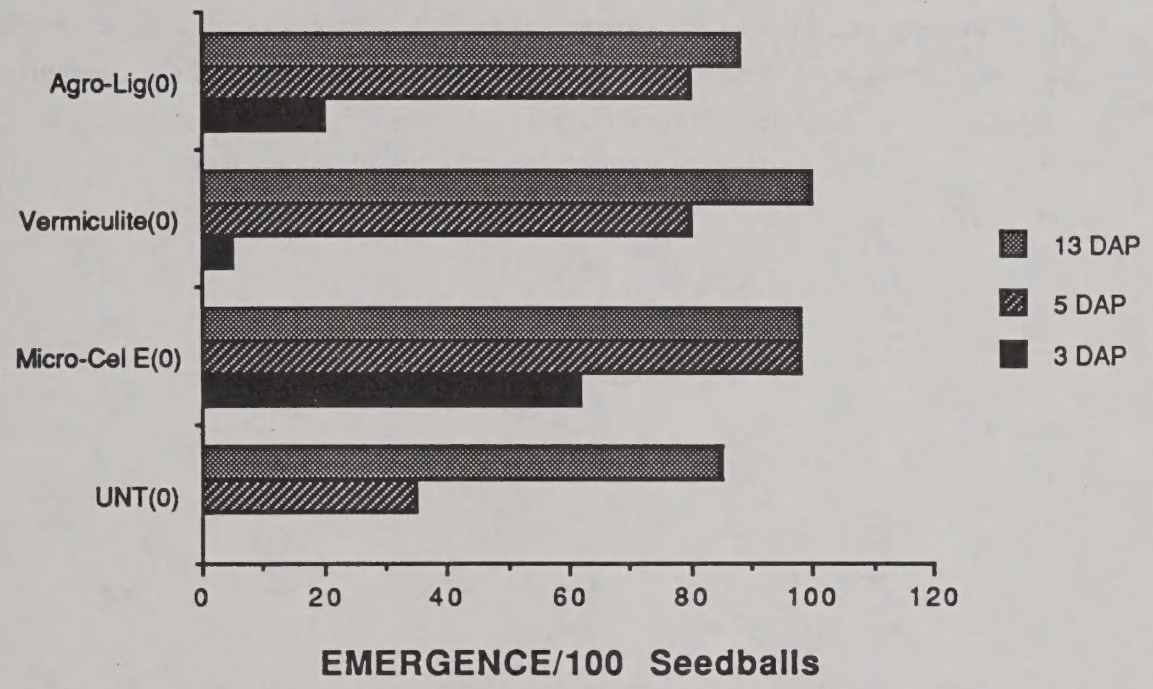
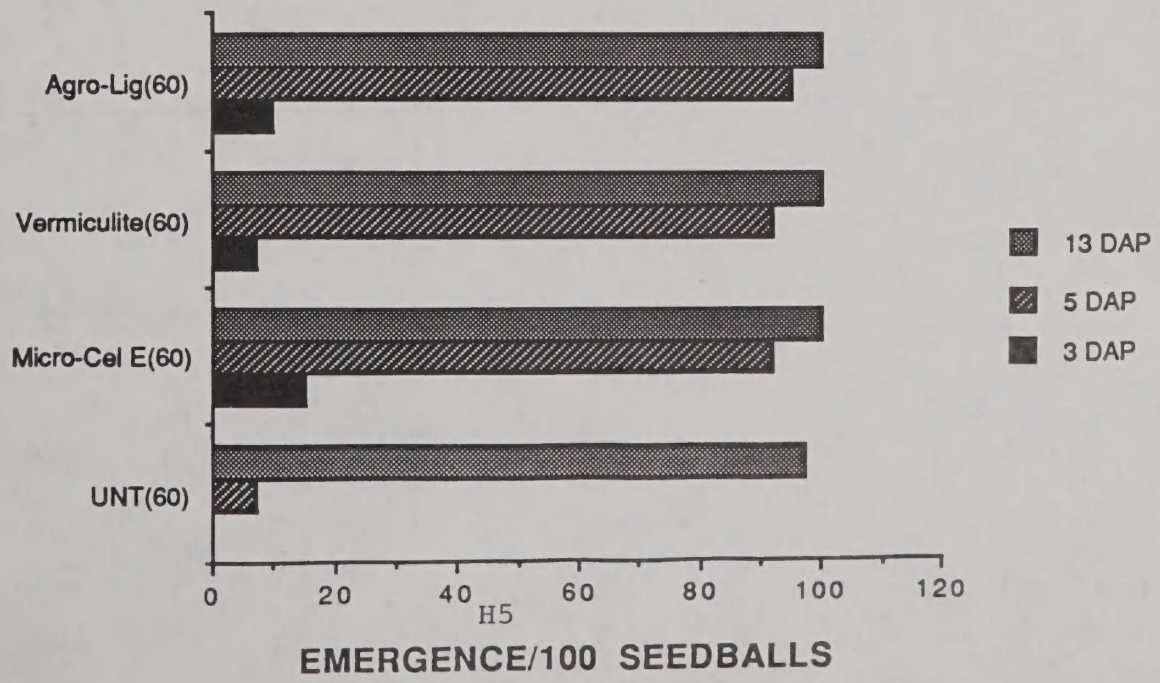


Fig. 3



Experiment 3. *Integration of preplant conditioning and fungicidal treatment of sugarbeet seeds to improve stand establishment*

In an early field planting of sugar beet seeds, a combination of fungicide and matriconditioning with Micro-Cel E proved most effective in improving emergence (Fig. 4). Conditioning alone reduced the emergence time and increased the stand size over that of the untreated or the fungicide (Apron+Thiram or Apron+Thiram+Rizolex) treated seeds. Maximum plant stand, however, was obtained when conditioning was combined with Apron+Thiram+Rizolex.

Fig. 4